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J: Courtney Thompson

# TWENTIETH ANNUAL REPORT

OF

# THE LOCAL GOVERNMENT BOARD,

# 1890–91.

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## SUPPLEMENT

CONTAINING THE

## REPORT OF THE MEDICAL OFFICER

**For 1890.**

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**Presented to both Houses of Parliament by Command of Her Majesty.**

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# ANNUAL REPORT

OF THE

# MEDICAL OFFICER

OF

# THE LOCAL GOVERNMENT BOARD

FOR THE YEAR

## 1890.

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# REPORT.

## TO THE RIGHT HONOURABLE CHARLES THOMSON RITCHIE, M.P., PRESIDENT OF THE LOCAL GOVERNMENT BOARD.



SIR,

I HAVE the honour to submit to you, for presentation to Parliament, my Report on the proceedings of your Board's Medical Department during the year 1890. Introduction. Progress of Department.

A Report on Epidemic Influenza has already been presented, and is not here reproduced. Also, numerous inquiries made for the purposes of the Vaccination Commission will not be recorded in the present volume.

The number of recorded references made to this Department for advice in matters relating to the Board's administrative business has amounted to upwards of six thousand during the year.

Inquiries by Medical Inspectors have been made as usual into the administration of the Vaccination laws, and in furtherance of other objects of Public Health. The occasion for these other inquiries has sometimes been found in local applications, sometimes in the Board's own purposes of supervision or sanction. At one time the inquiry has been into prevalences of disease, or local shortcomings in sanitary administration, at another time into the adaptation of byelaws to a district, into proposals for hospital provision, and the like.—I have in previous reports made mention of the useful function that devolves on the Medical Department, of giving aid and counsel to professional officers of local sanitary authorities; and I have the satisfaction to record that this consultative function of the Department has grown in importance during recent years. Local inquiries. Departmental advice.

I am happy to think that in these and other ways the usefulness of the Medical Department has been sustained, and that its work in past years is bearing ever more fruit. As an illustration, I may be permitted to record your Board's successful advocacy of isolation hospitals. Ten years ago Dr. Thorne Thorne and Mr. Power made study of the use and influence of hospitals for infectious diseases, as affording protection to communities against the spread of infection; and their reports gave demonstration, on the one hand, of advantages extending beyond the actual sick for whose benefit the hospitals had been primarily intended, and on the other hand, something of the conditions to be observed if the object of preventing the spread of infection had to be attained. These lessons have been

Medical Officer's Report.

laid to heart by the responsible authorities, and I should not be far wrong in asserting that England, outside the metropolis, has in these ten years doubled its amount of permanent hospital provision for the sick who require isolation; with corresponding increase of control over important infectious diseases.

Ten years ago a return was made to Parliament (378.—Sess. 2, 1880) of the inspections made by my Department with regard to prevalences of disease in particular places, and to defects in sanitary administration. I append to the present Report (App. C.) a list of the inspections since made. It will serve as an index to those inspectorial reports which have been printed in my volumes for 1880–90 inclusive.

It will be my duty, in later pages of this Report, to give some account of the researches made for the Department with aid from the Parliamentary Grant for Auxiliary Scientific Investigations. These have, as in recent years, been principally into the fields of pathology and pathological chemistry.

The Department has recently lost the services of three of its most esteemed Inspectors. On Dr. Stevens's retirement, after nearly 30 years of highly valued service, Mr. Sweeting was appointed an Inspector; on Dr. Page's death in 1890, Mr. T. W. Thompson succeeded him, and on Mr. Spear's death in the spring of the present year, you have been pleased to appoint Dr. Theodore Thomson to the vacant Inspectorship.

## *I.—ADMINISTRATIVE RELATIONS OF THE MEDICAL DEPARTMENT.*

### 1. Vaccination and Public Vaccination.

Vaccination.

The digest of *Vaccination Officers'* returns (Appendix A., No. 1) has reference to the calendar year 1888, and shows that out of the total children born in England and Wales during that year, 8·5 per cent. had not, so far as the vaccination officers were aware, been successfully vaccinated at the date of the returns being made up, *i.e.*, on January 31st, 1890. These figures point to an increase of disobedience to the laws concerning vaccination, and the increase is manifested both in London and in other parts of the kingdom. The growth of this disobedience has been something more than is customarily witnessed between periods of small-pox epidemicity. At the time of writing, the unusual interval of six years has elapsed since any general epidemic of small-pox occurred in England.

The bulk of the 8·5 per cent. of children not certified to have been successfully vaccinated consists of infants whose vaccination was postponed, or who had not been found by vaccination officers. A few infants are recorded as not-vaccinated, owing to their having passed through small-pox; but

a larger portion than heretofore (0 · 2 of the above 8 · 5 per cent.) of the not-vaccinated children were certified as "insusceptible" to vaccination. The proportion of so-called "insusceptibility" certificates continues to be larger in London than in the provinces. The number of infants thus certified was 1,888 for England and Wales.

It was thought well during the past year to reprint, for the information of vaccinators in general, the paper which appeared in my Report of 1889 on the significance of these "certificates of insusceptibility."

Public vaccination.

The usual inspections of *Public Vaccination* have been made during the year 1890 by Inspectors of your Medical Department. The inquiries have extended to 284 unions, and have taken account of 1,386 vaccination districts. The arrangements for public vaccination have been found to be generally satisfactory, and 876 recommendations for awards of money have been made (Appendix A., No. 2). The Local Government Act of 1888 has provided for these awards being paid to the respective public vaccinators out of county funds, upon the certificate of your Board.

National Vaccine Establishment.

*National Vaccine Establishment.*—There was but one change during 1890 among the Teachers and Examiners in Vaccination; Mr. McLellan having succeeded Dr. McVail at the Glasgow West Vaccination Station.

Supplies of humanized lymph have, as usual, been received by the National Vaccine Establishment from selected educational and other stations, and have been submitted to the usual examination in the Establishment. The details of the supplies will be found in Appendix A., No. 3. Applications for this lymph amounted to 5,939.

Calf lymph was cultivated by Dr. Cory and the Assistant Director at the Board's station at Lamb's Conduit Street, where, in addition to the 14,128 charged ivory points sent to the National Vaccine Establishment, 7,220 primary vaccinations of children were performed. The usual high degree of success attended the operations here; and particulars of these are appended (A., No. 4).

Royal Commission.

In my last annual Report I made mention of the Royal Commission appointed to inquire and report concerning Vaccination under various aspects; and recorded that this Commission had recently issued a second report. It has since taken further evidence on the subject and has issued a third report, dated August 1890.

## 2. Other Administrative Business of the Medical Department.

Conferences and local inquiries.

Besides conferences held at the office between your officers and representatives of local sanitary authorities on the subjects

of local byelaws, the provision of local hospitals and the like, inquiries and conferences of this class were held by Inspectors of the Department in various localities, namely, at Barnsley, Halifax, Middlesbrough, Northampton, Norwich, Sheffield, and Wolverhampton; at Calverley, Edmonton, Keighley, North Bierley, Shipley, Windhill, and Thornton; and at Walton-on-the-Naze. Dr. Barry's report on the subject of isolation hospital provision in the Keighley Union is placed in the Appendix (A., No. 5).

In an appended paper (A., No. 6) I give a brief summary of the inquiries which were made by Inspectors of the Department during the year, and which usually had for their object to discover the conditions provocative of some prevalent disease. Irrespective of the investigation of Influenza, these inquiries, 22 in number, involved the inspection of 44 sanitary districts; and of the reports here summarised, the most interesting are reproduced in the following appendix.

Enteric fever.

The disease most commonly present, in the districts that were subjected to inquiry, was *Enteric Fever*, and without exception, where this fever was found, the commonplace conditions of excremental filth, particularly pollution of water supplies by such filth, were found. I would more particularly invite attention, in this connexion, to Dr. Blaxall's report on Staines Rural District (Appendix A., No. 7), as illustrating how a local authority has allowed enteric fever to be endemic in its district, under conditions which endanger neighbouring districts as well as its own, the neighbouring districts in this instance being no less than large parts of the Metropolis deriving their water supplies from the Thames.

I would also direct especial attention to Dr. Barry's interim report on an epidemic prevalence of enteric fever in the valley of the Tees. Reserving his complete report until he shall be able to use the facts of the new census, Dr. Barry gives an account (Appendix A., No. 8) of an outburst of enteric fever in the Tees Valley, occurring immediately after a heavy flood of the river, and selecting simultaneously those districts which procured their drinking-water from a certain section of the Tees. The circumstantial evidence of a relation between the fever and the water supplies was such as might have sufficed to implicate the one as a cause of the other. But furthermore we are told that no other common condition belonging to the several districts could be discovered, bar that of water supplies from the same part of the Tees; and presently we learn that the river, before it reaches this place, habitually receives in abundance the excrements of people higher up the stream. This fact was perfectly well known in the districts which derive their drinking-water from this part of the river. It was well for Stockton, Middlesbrough, and Darlington that the specific poison contained in the excrements befouling the Tees in 1890 was not that of Asiatic cholera.

*Diphtheria* was present in a number of other districts inspected during the year; but these occasional observations of the disease have not added to our knowledge of the local conditions concerned in its prevalence. The disease is considered in reports by Dr. Blaxall and Mr. Spear (Appendix A., Nos. 9 and 10) on Berkhampstead and Stalybridge. The familiar histories of school diphtheria at the former, and of nomenclature difficulties in the latter place, are recorded afresh. Diphtheria.

A rural district of Wales—Neath (Appendix A., No. 11)—was visited by Mr. Spear on account of a severe and fatal epidemic of *Scarlatina*. The fever had had every opportunity of spreading; it had been "notified," and the notification certificates had been simply filed. Nothing was done beyond the favourite nostrum of "giving some chloride of lime." Houses were dirty and unwholesome, and sometimes overcrowded; there was no opportunity for isolating the sick, and children attended the schools while their skins were peeling from scarlatina. Scarlatina.

Readers of my Annual Reports will hardly need to be reminded of Dr. Ballard's history of *Epidemic Pneumonia* at Middlesbrough in 1888, and the behaviour of the disease there after the fashion of an infection; how it showed a strong tendency to occur in groups of cases, with sequence of attacks among members of the same group, and under various conditions of drain filth. Very much the same story is given by Dr. Parsons in the present report (Appendix A., No. 12) of a prevalence of pneumonia occurring in certain villages of Lincolnshire. In Scotter, the village principally affected, 16 cases of pneumonia (with other illnesses suspected to have the same nature) had, in the course of three months, occurred in a population of some 7–800 persons, and twelve of the sixteen were fatal.* The suggestion was made by Dr. Ballard to feed some tame mice on sputa of the pneumonia patients, and Dr. Parsons records that the mice became ill, and that some of them died. Their lungs were found by Dr. Klein acutely inflamed after death, and from the lungs he "obtained a bacillus identical with that found by "him in the Middlesbrough cases reported on by Dr. Ballard." The circumstances under which this pneumonia prevailed in Scotter resembled in their chief respects those observed at Middlesbrough; and it is worthy of note that this village has in former times suffered from epidemic attacks similar in kind but less fatal; and also that during the first half of 1890, 13 certificates of death received by registrars from other parts of the Gainsborough Rural Sanitary District make mention of pneumonia as the cause (or one of the causes) of death. Pneumonia.

Cases of illness regarded as being *Cerebro-spinal Meningitis* were reported to your Board in the summer months of 1890, and were the subject of investigation by Dr. Bruce Low. I refer to the brief but very interesting report which he has made Cerebro-spinal Meningitis.

* The disease did not appear to be related to the influenza which had shown itself in this district some months before.

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(Appendix A., No. 13), for an account of the symptoms of these cases, and of their distribution through certain villages in the Eastern Counties. The evidence may not be enough to prove the identity of the disease observed in these places with that foreign epidemic considered by Dr. Thorne in my Report for 1888; but there are sufficiently disquieting resemblances in the accounts of the two; and the circumstance that in Dr. Low's cases the fatality in proportion to attacks has been but small, can hardly be regarded as distinguishing the disease from that which has from time to time been showing itself in Germany and in the basin of the Mediterranean.

Other inquiries.

Some of the reports of 1890, which I have placed in my Appendix A., Nos. 14–18, are of less interest on account of the actual presence of disease at a particular moment than by reason of the pictures they afford of districts either in want of medical guidance, or refusing to be guided by medical experience.

Reference has been made, in a previous paragraph, to the report on *Epidemic Influenza* which has been issued in anticipation of the present volume. It relates to prevalence of the complaint during 1889–90, and gives some supplementary matter of later date. Dr. Parsons's inquiry, it is hardly necessary to say, occupied him during the greater portion of the year. I reprint among the appended papers (A., No. 19) the few pages in which I introduced Dr. Parsons's report to your notice.

Typhus fever.

A number of towns known or suspected to have been invaded by *Typhus* fever were visited for the Department by Mr. Spear during the winter of 1890. They were principally towns on the coast of Lancashire and Cumberland, and one or two were colliery districts in Northumberland. The object of Mr. Spear's visit was to impress on local authorities the value of early recognition of cases of this fever and the importance of getting the cases speedily removed into places of safety. He was to urge the need for having such places in readiness, and to enjoin constant watchfulness against overcrowding of houses, particularly of such as were frequented by tramps. I have reason to think that Mr. Spear's monitions received attention, and that the action of the local authorities was effectual in preventing epidemic extension of typhus. The commencement of Mr. Spear's fatal illness prevented him from reporting particulars of his observations and procedures.*

Ports and rivers.

Inquiries in aid of the organization of *Port Sanitary Districts* were made during the year by Dr. Blaxall at Great Yarmouth and at Sandwich; and, with a view to the constitution of representative bodies empowered *to protect Rivers against Pollution,* Dr. Barry and Mr. Thompson took part in inquiries respecting the rivers Aire, Irwell, and Mersey.

* Mr. Spear's untimely death will be matter of special regret to the Department, when outbreaks of typhus have hereafter to be investigated. He was, or believed himself to be, insusceptible to this disease; and there was no hesitation about exposing him to the infection of typhus. The Department once lost a valued inspector by this fever.

Exceptional watercloset constructions.

For the purposes of the Medical Department, in advising the Board as to the sanction to be given to certain proposals by sanitary authorities for regulating *Watercloset construction*, Dr. Parsons has during 1890 made personal investigation of certain arrangements in actual use in some towns of England : *see* Appendix A., No. 20. They are arrangements that do not profess to be adapted for indoor use, and they have for their object either to economize water where water is scanty, or to provide (as far may be) against injury to health from the misuse of waterclosets. In the first case the endeavour has been to utilize rain or sink-water for washing out closet-pans ; and it is found that this can be attained with some success when a vessel is provided for the accumulation of driblets of water, with automatic discharge when the water has reached to a certain level in the vessel. In the other case it is found that waterclosets can be so contrived as to fulfil their proper object, in spite of dead cats and other refuse cast into them, in outdoor places where the closets are grouped over a common water-trough.* The latter type of closet claims recognition for itself by appeal to actual circumstances: especially, to the water-closet having to be used by a population previously addicted to the "midden privy." Dr. Parsons reports the trough-closet to be, for districts which have provided themselves with proper water service, drains and sewers, an arrangement permissible under certain conditions which can probably be defined.

Food-poisoning.

Dr. Ballard has given me (Appendix A., No. 21) a review of occurrences that have come under the notice of the Medical Department since 1879, in which disease presenting specific characters has been communicated or spread by articles of food—the so-called "*Food-Poisonings.*" Among other inferences he has arrived at the following significant result; that with hardly an exception the inculpated food either (*a*) had been kept in a raw state, in order to undergo some manufacturing process before sale, and was of a kind specially liable to be insufficiently cooked ; or (*b*) had been kept for a while after cooking, and had been mischievous when eaten in its cold state, whereas it had done no harm to people who had partaken of it while hot. And from these and other considerations, Dr. Ballard is disposed to infer that, in this class of cases, the morbific quality has commonly not been inherent in the animal furnishing the food, but has been obtained by the food *from its surroundings*, during the time that the food-material was being kept. His lesson is, that more care should be given to secure the most cleanly and wholesome conditions for pantries, larders, and kitchens, where food is stored, as well as for places where flesh-meat is being kept during any process of preparation for sale.

* Experience of trough-closets, some with automatic flushing, was obtained for the Medical Department in 1873 by Mr. J. Netten Radcliffe ; and he found them in some places working satisfactorily, in other places not. The difference had depended upon the degree of directness and completeness of the supervision exercised by the Sanitary Authority over such closets.

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The case, recently reported to the Board by Dr. Mumby of Portsmouth, which forms the subject of experimental research (to be recorded hereafter) by Dr. Klein, lends itself perfectly well to this interpretation of the mechanism of food-poisoning.

Lead in water supplies.

In my recent annual Reports, when reporting on certain laboratory investigations into *Lead-poisoning* by the water supplies of various towns, I pointed out that any chemical and bacteriological studies of the circumstances which give to water the faculty of dissolving the lead from delivery pipes ought to be accompanied by simultaneous investigations made at the various gathering grounds of the water supplies; inasmuch as the practical object should be to learn the conditions under which waters *can acquire* a power of dissolving lead. This view has received your approval, and Mr. Power has been charged, with the assistance of Dr. Barry and Mr. Thompson, to organize a system of observation concerning the origin and circumstances of waters found to have plumbo-solvent quality. The primary step has been to learn the facts as to the prevalence of lead-poisoning in various populations; and in the first instance information has been sought from the Medical Officers of Health of several hundred sanitary districts of Lancashire and West Yorkshire, a part of the country which has appeared to suffer more than others under this form of poisoning. For the West Riding of Yorkshire Dr. Barry has already summarized the information thus derived; and a basis is thus being gained for detailed investigation of the conditions in question. The inquiry cannot be rapidly pushed forward, owing to the limited inspectorial resources of the Department; but your view of its necessity will be confirmed by Dr. Barry's preliminary record that districts with upwards of 600,000 persons, in the West Riding of Yorkshire alone, appear from the statements of their Medical Officers of Health to be at one or another time liable to lead-poisoning by the drinking-water supplied to their populations.

Re-issued Orders and memoranda.

The Orders of the Board previously in force and having reference to *Cholera* in England and Wales have been superseded during the year by a single Order which has application to all Port and Maritime Sanitary Districts, and while imposing some fresh powers and duties on the authorities of such districts, introduces some improved means of notifying the presence of cholera. The text of this Order is given in the Appendix (A., No. 22), for the information of those who seek to understand the English system of "medical inspection," as opposed to "quarantine," in dealing with this foreign disease.

Following on a re-issue, last March, of your Board's Orders relating to *Medical Officers of Health*, it was thought expedient to print as a separate paper the section defining the Duties of a Medical Officer of Health. This section, together with some introductory memoranda as to the annual reports to be made by these officers, is placed in the Appendix (A., No. 23).

Medical Officer's Report.

The memorandum "On the circumstances under which the "Closing of Public Elementary Schools or the Exclusion there-"from of particular Children may be required in order to "prevent the spread of Disease," prepared some years ago in the Medical Department, was edited afresh in the year 1890, and it forms A., No. 24, of the appended papers.

## *II.—AUXILIARY SCIENTIFIC INVESTIGATIONS.*

Pathology of diphtheria.

Dr. Klein has continued through the year 1890 the pathological researches into diphtheria which occupied him during the two previous years (Appendix B., No. 1). In last year's Report I recorded the striking results already attained; his identification, from among similar forms, of a particular bacillus constantly present in diphtheria-membranes, with the relation of this bacillus to a diphtheria-disease in rodents and to a characteristic diphtheria-disease in cats. I recorded also his application of this knowledge to an examination of the behaviour of diphtheria in milch cows; how he had produced in them by this bacillus a disease which, among other symptoms, had exhibited eruptions on the udders, and had been attended by the diphtheria bacillus in the milk.

In milch-cows.

Extending in 1890–91 his observations upon milch cows, Dr. Klein has now to report additional instances in which inoculation with cultures of *bacillus diphtheriæ* gave rise to disease having the same pathological characters as those witnessed in 1889–90. The several cases varied, indeed, somewhat in their clinical manifestations. It was found that loss of hair was more marked in some cases than in others, and that in some very severe attacks there was no eruption on the udders. The milk in one case contained the characteristic bacillus at one stage and not at another stage; and such observations as were made of the milk give rise to a provisional belief that diphtheria in milch cows can pass through all its stages without this bacillus appearing in the milk. For the rest, Dr. Klein's attention has been given to a comparison of the action of diphtheria material introduced into the body by food and by inoculation.

General considerations.

Readers of Dr. Klein's present report may think that they discern indications of a morbific quality superadded to micro-organisms previously harmless. If such quality can be acquired, it is not surprising that indications of its acquisition should be first noted in the case of the bacillus of diphtheria; a disease which we have learned by experience to regard as among the least "specific" of the infections met with in human communities.

Concurrent infections.

Dr. Klein's study of the Influence of one Infection upon another has been extended during the past year (Appendix B., No. 2). Sometimes his experiments were made by simultaneous inoculation of two infections, sometimes by the inoculation of one shortly after the other. They have all been made upon guinea-pigs, and the infections used in his experiments have been such as are rapidly fatal to those animals. Inoculating anthrax

MEDICAL OFFICER'S REPORT.

shortly after inoculating with diphtheria, he has found that anthrax ran its usual course apparently unaffected by the earlier inoculation, and this was the case equally whether the bacillus of diphtheria was used in its less active or in its more active form.

Use of chemical products,

Dr. Klein's other experiments, varying somewhat from their original design, have had for their object to learn the influence of the *chemical products* of certain bacteria—not of inoculated bacteria themselves—upon the progress of disease caused by other bacteria. The chemical products which he submitted to investigation were those obtained by the growth

of bacillus pyocyaneus,

of *bacillus pyocyaneus* in broth. These products had been found by previous observers to be antagonistic to the development of anthrax-disease inoculated into the guinea-pig; and

qua anthrax,

Dr. Klein now sought to ascertain whether by this means any antagonism was exerted against the action of diphtheria when the bacillus of diphtheria was subsequently inoculated into the

qua diphtheria,

same animal. In the case of this infection, he found that instead of an antagonistic action, the chemical products of bacillus pyocyaneus served rather to enhance the activity of the resulting disease.

qua tubercle.

Dr. Klein has made further examination of the chemical products of bacillus pyocyaneus as affecting the development of tubercle; and his results will be reported hereafter. They promise to be of much practical importance; for Dr. Klein states that "evidence has already been attained to justify an "expectation that the chemical products of bacillus pyocyaneus "will be found to have distinct inhibitory action on the "tuberculous process."

Researches of Koch.

While these hopeful experiments of 1890 were being conducted in England, the medical profession and the public heard from Berlin about a "cure" for tuberculous patients to be got by the injection into their bodies of the chemical products of the bacillus of tubercle itself. This result, of such magnificent import to man and to other animals, had been achieved, we were told, by Prof. Koch's researches. The announcement, however, was undoubtedly made in too unqualified terms, and circumstances over which Prof. Koch had no control have apparently debarred him from giving particulars of his researches, their conditions and their limitations. Up to this time no uniformly satisfactory result to human subjects has been gained by injections of "tuberculin." But Prof. Koch's investigations are still in progress, and we may expect that he will, by following his present lines of observation, yet succeed in obtaining a method of defence against tubercle.

Food-poisoning,

Reference has been made in a previous section of this Report to a case of food-poisoning at Portsmouth. The opportunity was afforded to Dr. Klein for experiment with the poisonous materials. He found (Appendix B., No. 3) that these matters had, when he received them, definitely poisonous properties upon

mice; and that with lapse of time this poisonous action was lost. At the time when the materials were poisonous, they exhibited in great abundance two forms of bacillus, the one mobile, the other non-mobile. After the materials had lost their poisonous quality they continued to exhibit bacteria in great abundance, especially the mobile bacillus above mentioned, but the non-mobile was now no longer to be found. Dr. Klein's final results, which contain the explanation of the Portsmouth cases, point (*a*) to a chemical substance generated in the food-material by the non-mobile bacillus and poisonous when taken into the alimentary canal; and (*b*) to a process of putrefaction—during which the mobile bacillus superseded the non-mobile bacillus, and by which the power for harm of the materials in question became destroyed.

loss of poisonous quality.

Cases of this sort serve to emphasise the general propositions that have been upheld in these Reports, when the study of harmless organisms as well as those recognised as morbific has been commended to bacteriologists.*

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* Reporting *inter alia* on Processes of Disinfection, and on the Organisms seen in Drinking-waters, I had occasion to say, in 1885, "* * * * * Dr. "Dupré's observations on these deep-well waters illustrate how greatly we need "research into the ways of harmless bacteria, as well as into the habits of those "which produce disease. For, looking at the prodigious part that bacterial life "plays in the economy of nature, it is hardly too much to expect that morbific "bacteria may come hereafter to be known, not merely as producing disease under "certain conditions, but as having, under other conditions, many other functions in "that economy. When such bacteria are so circumstanced that they can produce "disease, the best thing we can now do may be to poison or boil them; but while "provisionally we use such resources, science may expect hereafter to see beyond "them. The larger aim of sanitary science, in relation to each harmful bacterium, "will be to turn against it such forces of nature as are customarily antagonistic to "it. 'The termination of a case of infectious disease by recovery of the individual, "the end of an epidemic in the community, the limitation of area over which "infection spreads, of the length of stream along which it can be carried, all point "to the existence of such forces. It has long appeared to pathologists that, among "agencies antagonistic to the bacteria of disease, none will be found to equal in "potency the agency of other bacteria; that probably the 'self-purifying' power of "our rivers, for example, is the power of some stronger, septic [saprophytic], bacterium "to destroy the weaker and more mischievous bacteria which are discharged by sewers "into our rivers. So that if, among bacteria, as among higher creatures, natural "hostilities of that sort result in the destruction or repression, supersession or "assimilation, of the weaker by the stronger organism, the study of such hostilities "is the study to which we may most hopefully appeal for resources against the "forms of bacterial life which we now only know as agencies of disease.

"At present we know too little of the natural history of this class of organisms. "We recognise among them differences of form; differences in the mode of their "growth, in the mode of their reproduction; differences, as we believe, in the "degree of their dependence upon air, and in their resistance to one and another "degree of heat, in their effect upon this or that chemical substance, and *vice versâ*. "But we know very little more than this, and practically nothing of the means by "which any bacterium exerts its influence in the production of a chemical change "or of a disease.

"Yet if we are to understand the part that bacteria play in the production of "disease, and if, in our endeavours to prevent and modify bacterial disease we "may hope for the aid of other bacteria and of like beings, we require extended and "exact knowledge of their life history of their characters, qualities, and habits, of "their abilities, affinities and antagonisms; and this knowledge we need, not alone "for those which under some circumstances of their existence may be competent "to produce disease, but also in respect of those which are harmless and which "may, if rightly utilised, be of avail to us in repressing disease."

Inquiry needed into harmless bacteria.

Chemistry of anthrax.

It may be remembered that Dr. Sidney Martin, in his investigation of the Chemistry of Anthrax in 1889, succeeded in obtaining, by the growth of the bacilli in simple organic (but unorganised, "*ungeformte*") materials, certain distinctive products, the earlier being proteid in their nature, albumoses, the subsequent being an alkaloidal product, forming crystallizable salts; and that Dr. Martin put these substances to the test, with the result of obtaining by their means lesions peculiar to anthrax, though the bacilli of anthrax were absent. During 1890, (Appendix B., No. 4,) Dr. Martin's experiments have had further concern for the physiological action of these anthrax products. After a number of observations with the mixed proteids and alkaloid, he proceeded to investigate anew the action of the two substances apart from each other. Such result as had been gained by his previous researches had shown no material difference except in degree of severity between the phenomena resulting from the albumoses and those produced by the anthrax alkaloid.

Operation of several products upon animals.

But in Dr. Martin's later observations a more definite distinction has appeared; and now we learn that it is the anthrax-albumoses (and not the alkaloid) that give rise to the fever of anthrax, whereas it is more especially to the anthrax-alkaloid (rather than to the albumoses) that the local œdema and coma of anthrax are to be attributed. The albumoses, as such, have indeed seemed to possess but little specific quality; the fever produced by them being much the same as that producible by the familiar albumoses of peptic digestion. It is essentially, it would appear, the alkaloid (resulting from further change of the albumoses) which is the cause of the specific phenomena and of death in anthrax.

Recognition of anthrax-alkaloid in tissues of animals.

So far the results had been obtained by the growth of anthrax bacilli upon simple unorganised materials. It was desirable to examine, from the standpoint thus gained, the chemistry of the tissues and organs ("*geformte*" substances) of animals that had been made the subject of anthrax. Upon this examination the important additional facts have been gained:—an alkaloid was separated from the bodies of these animals, and it gave the same chemical reactions and produced the same physiological effects on animals, as did the alkaloid obtained in Dr. Martin's artificial cultures of the anthrax bacillus.

Chemistry of attenuation.

During the course of last year's investigations Dr. Martin had occasion to deal with virulent anthrax bacilli and with such bacilli in an attenuated form. He sought to learn the chemical significance of the difference, and found that the attenuated and the virulent bacilli, grown in quite comparable conditions, yielded the same chemical products, but that the one grew more rapidly than the other and afforded a greater quantity of these products. In both forms the bacilli showed spores.

Dr. Martin has not yet recorded the results of his experiments as to any protection to be had by the inoculation of animals with his anthrax products.

As introductory to a study of the chemistry of Susceptibility and Insusceptibility, Dr. Hamer (Appendix B., No. 5) has had to make investigation of the doctrine of phagocytosis, which has recently been advanced to explain certain well-established facts about insusceptibility, This doctrine asserts that certain corpuscles in the tissues of an infected body have the faculty of destroying, by some chemico-vital process analogous to digestion, the bacteria of disease. Dr. Hamer has examined some of the statements made by Metschnikoff and others, as to the relative quantity of these bacteria-consuming cells in chronic and acute infections, and he does not find their statements to accord with his own observations.

Susceptibility to infection.

Phagocytosis.

From these considerations alone, it would appear that Dr. Hamer's investigation into the conditions for insusceptibility will most conveniently and at present proceed without reference to the doctrine of phagocytosis. And learning, what we now learn from Dr. Martin's researches, as to the identity of the chemical substances produced in the living body by the operation of anthrax bacilli, and the chemical substances resulting from the operation of the same bacilli upon unorganised proteids; it would seem that the problem of Insusceptibility is not straightway to be solved by an appeal to phagocytes.

In a concluding paper of Appendix B. (No. 6) Dr. Andrewes records examination by him of the micro-organisms associated with suppuration and with phlegmonous and other inflammation in the human subject. He has verified current beliefs as to the concern of Staphylococcus with circumscribed suppurations and of Streptococcus with spreading (phlegmonous) inflammations; and he has extended his study to details of the life history of Staphylococcus pyogenes (aureus and albus) within the bodies of experimental animals. It had also been Dr. Andrewes' intention to study, differentially, the life histories of Streptococcus erysipelatosus (Fehleisen) and Streptococcus pyogenes. But he was not able to obtain the erysipelas organism in an active state and under conditions facilitating the comparison desired.

Organisms of suppuration and like processes.

I have the honour to be,
Sir,
Your obedient servant,
GEORGE BUCHANAN.

August 1891.

# APPENDIX.

# APPENDICES.

## APPENDIX A.

### No. 1.



DIGEST of the VACCINATION OFFICERS' RETURNS, with regard to CHILDREN whose BIRTHS were registered in the Year 1888.

THE following is the seventeenth annual return under the Vaccination Act, 1871. Of 879,813 births returned to the Board by the several Vaccination Officers in England and Wales as registered during the year 1888, the number which at the time the return was made had been registered as successfully vaccinated was 719,103. This number is 81·7 per cent. of the whole. The children whose births were registered during the year, and who were not recorded as successfully vaccinated, numbered 160,710. Of this number, 83,827 were registered as having died unvaccinated.* Out of the same number, 1,888 had been registered as insusceptible of vaccination; 12 as having contracted small-pox and, therefore, not needing to be vaccinated; 12,282 as having their vaccination postponed by medical certificate; and there remained on the Vaccination Officers' registers 62,701 children born in 1888, who had "removed," were "not to be traced," or were otherwise unaccounted for. If from the 879,813 births returned by these officers deduction of the deaths without vaccination be first made, it appears that of the remaining 795,986 children, there were registered at the time of the return 90·3 per cent. as successfully vaccinated; 0·2 per cent. as either insusceptible of vaccination, or as having had small-pox; and 1·5 per cent. as under medical certificate of postponement; leaving 7·9 per cent. as at that time still unaccounted for as regards vaccination.

The per-centage of children not finally accounted for as regards vaccination (*i.e.*, including cases postponed) was 8·5 of the total births (879,813); and this figure is given in the table following, in sequence to the records of former years.

By the latter method of computation, it appears that the proportion of cases not finally accounted for in the metropolitan returns for 1888 was 10·3 per cent.; in the provincial returns, 8·2. Of the registered births of the seventeen years 1872–88, the corresponding proportion not finally accounted for in regard to vaccination in each year respectively has been as follows:—

| — | Metropolis. | Rest of England. | — | Metropolis. | Rest of England. |
|---|---|---|---|---|---|
| 1872 | 8·8 | 4·5 | 1881 | 5·7 | 4·3 |
| 1873 | 8·7 | 4·2 | 1882 | 6·6 | 4·5 |
| 1874 | 8·8 | 4·1 | 1883 | 6·5 | 4·9 |
| 1875 | 9·3 | 3·8 | 1884 | 6·8 | 5·3 |
| 1876 | 6·5 | 4·0 | 1885 | 7·0 | 5·5 |
| 1877 | 7·1 | 4·1 | 1886 | 7·8 | 6·1 |
| 1878 | 7·1 | 4·3 | 1887 | 9·0 | 6·7 |
| 1879 | 7·8 | 4·5 | 1888 | 10·3 | 8·2 |
| 1880 | 7·0 | 4·5 | | | |

| — | Metropolis. | Rest of England. |
|---|---|---|
| Average of 5 years, 1873–77 | 8·1 | 4·1 |
| „ „ 1878–82 | 6·8 | 4·4 |
| „ „ 1883–87 | 7·4 | 5·7 |

* Of vaccinated children, dying before the returns are made up, no record is kept.

App. A. No. 1.

Digest of Vaccination Officers' Returns.

In 1888 the proportion of cases unaccounted for, after deduction of the postponed cases, in the metropolis and in the rest of England, was 8·9 and 6·8 per cent. respectively.

For purposes of comparison, an addition has been made to the table, showing the total number of cases unaccounted for during the previous five years, with the proportion which such cases bear to the entire number of births registered.

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*Note by the Medical Officer.*

As in my Reports for recent years, I am desirous of calculating, upon such data as are available, the number of children who, at the time the Vaccination Officers' Returns are made up, pass into the vaccinated class of the population, and the number that pass into the unvaccinated class. The result expressed in per-centages of the two classes cannot, I know, be absolutely correct; but I have satisfied myself that it cannot differ from the truth by more than a fraction of a unit per cent.

Vaccination Officers' Returns are made up to January 31st of the year but one following that to which returns relate. The interval between birth and return must therefore always be a twelvemonth and something more. This "something more" may be as little as one month, or as much as 13 months, according as the child is born at the beginning or the end of a calendar year:—the mean of the one and 13 months is seven months. [The following has reference to the Returns now presented.]

Let us as a first step examine the total mortality so far as recorded by the Registrar-General for the above period of childrens' lives, and apply our examination to the case of children born in 1888. We may take as a fair approximation to the mortality of children born in 1888 and dying during the first twelvemonth of life, the mean mortality at ages 0–1 of the years 1888–89; namely, 123,638.

We may take as a fair approximation to the mortality of children born in 1888, surviving their first year and dying in the course of 1–13 months afterwards, seven-twelfths of the mortality at ages 1–2 of the year 1889; namely: $\frac{7}{12} \times 41,884 = 24,432$.

The sum of the two figures 123,638 and 24,432 (viz.:—148,070) represents then with sufficient accuracy the total mortality occurring up to January 31st, 1890, among the children born in 1888. But the births of 1888 numbered 879,813, and therefore there remains a balance of 731,743 children, vaccinated and unvaccinated together, born in 1888 and surviving January 31st, 1890.

As a second step let us examine the returns of the Vaccination Officers made up to January 31st, 1890, and relating to the births of 1888. We find there a record of 83,827 deaths known to have occurred among unvaccinated children.

We find from the same returns a number of children born in 1888, and recorded as neither dead nor vaccinated on January 31st, 1890. The number of these unvaccinated survivors at the date in question was 76,883.

The difference between the total survivors and the unvaccinated survivors represents the number of children born in 1888 who, having been vaccinated, survived January 31st, 1890, the date to which Vaccination Officers' returns for 1888 are made up. This number is 654,860; vaccinated survivors.

[These numbers no doubt may deviate a little on one or the other side, from the precise number of deaths and survivals; but the deviations cannot be very large, and some of them would seem compensatory of each other.]

On February 1st, 1890, therefore, the survivors of those born in 1888 were pretty closely as follows:—

| | | |
|---|---|---|
| Vaccinated children | 654,860 | 731,743 |
| Unvaccinated children | 76,883 | |

or, per cent. of all survivors,

| | |
|---|---|
| Vaccinated children | 89·5 |
| Unvaccinated children | 10·5 |

[I have said "pretty closely"; and a judgment may be formed of the extent of any probable error by noting that the transfer of 1,000 from the one to the other number would alter the respective per-centages by less than a quarter per cent.]

This per-centage 10·5 is made up of—

0·3 per cent. (1,900) certified as insusceptible of vaccination or as having already had small-pox.

1·6 „ (12,282) vaccination postponed by medical certificate.

8·6 „ (62,701) unaccounted for.

G. B.

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| | Returns, 1888. | | | | | | | | Children remaining "unaccounted for" when the Returns for the several Years were received. | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Births. | Successfully Vaccinated. | Insusceptible of Vaccination. | Had Small-pox. | Died unvaccinated. | Vaccination postponed. | Remaining. | Children not finally accounted for (including cases postponed), per cent. of births. | Total Number for the Years 1883-87. | Average Per-centage for the Years 1883-87. |
| ENGLAND & WALES - | 879,813 | 719,103 | 1,888 | 12 | 83,827 | 12,282 | 62,701 | 8·5 | 267,644 | 6·0 |
| Ditto (excluding Metropolitan Unions). | 748,039 | 613,908 | 1,394 | 11 | 71,285 | 10,495 | 50,946 | 8·2 | 217,820 | 5·7 |
| Metropolitan Unions - | 131,774 | 105,195 | 494 | 1 | 12,542 | 1,787 | 11,755 | 10·3 | 49,824 | 7·4 |
| COUNTIES. | | | | | | | | | | |
| England: | | | | | | | | | | |
| Bedford - - - | 4,847 | 3,446 | 7 | — | 492 | 129 | 773 | 18·6 | 2,084 | 8·3 |
| Berks - - - | 7,419 | 6,362 | 25 | — | 619 | 136 | 277 | 5·6 | 1,710 | 4·4 |
| Bucks - - - | 4,837 | 4,284 | 10 | — | 397 | 29 | 117 | 3·0 | 838 | 3·4 |
| Cambridge - - | 5,553 | 4,857 | 9 | — | 454 | 92 | 141 | 4·2 | 832 | 2·9 |
| Chester - - - | 20,135 | 17,430 | 36 | — | 1,872 | 217 | 580 | 4·0 | 3,398 | 3·2 |
| Cornwall - - - | 8,898 | 7,463 | 6 | — | 860 | 178 | 391 | 6·4 | 1,727 | 3·7 |
| Cumberland - - | 8,536 | 7,435 | 2 | — | 741 | 128 | 230 | 4·2 | 1,733 | 4·0 |
| Derby - - - | 13,214 | 11,064 | 23 | — | 1,234 | 160 | 733 | 6·8 | 4,511 | 6·6 |
| Devon - - - | 17,396 | 14,896 | 24 | — | 1,473 | 339 | 664 | 5·8 | 3,440 | 3·9 |
| Dorset - - - | 5,132 | 4,463 | 3 | — | 361 | 81 | 224 | 5·9 | 1,187 | 4·4 |
| Durham - - - | 35,263 | 29,110 | 35 | — | 3,376 | 464 | 2,278 | 7·8 | 9,856 | 5·5 |
| Essex - - - | 22,986 | 18,980 | 60 | — | 1,809 | 471 | 1,666 | 9·3 | 7,657 | 7·0 |
| Gloucester - - | 15,625 | 11,946 | 60 | — | 1,387 | 346 | 1,886 | 14·3 | 5,041 | 6·3 |
| Hereford - - - | 3,178 | 2,776 | 6 | — | 237 | 48 | 111 | 5·0 | 612 | 3·9 |
| Herts - - - | 7,118 | 6,093 | 13 | — | 578 | 104 | 330 | 6·1 | 1,320 | 3·6 |
| Hunts - - - | 1,412 | 1,268 | 1 | — | 108 | 13 | 22 | 2·5 | 136 | 1·8 |
| Kent (extra-metrop.) - | 23,216 | 19,773 | 31 | — | 1,847 | 389 | 1,176 | 6·7 | 5,379 | 4·6 |
| Lancaster - - | 128,510 | 102,913 | 289 | 3 | 13,514 | 1,394 | 10,397 | 9·2 | 38,798 | 6·0 |
| Leicester - - - | 12,127 | 5,783 | 9 | — | 1,621 | 121 | 4,593 | 38·9 | 16,384 | 27·5 |
| Lincoln - - - | 13,441 | 11,339 | 27 | — | 1,416 | 215 | 444 | 4·9 | 3,765 | 5·2 |
| Middlesex (ex.-metro.) | 15,079 | 12,331 | 48 | — | 1,211 | 209 | 1,280 | 9·9 | 6,170 | 8·7 |
| Monmouth - - | 8,676 | 7,423 | 12 | — | 777 | 159 | 305 | 5·3 | 1,675 | 3·8 |
| Norfolk - - - | 13,751 | 11,503 | 14 | — | 1,333 | 272 | 629 | 6·6 | 2,854 | 4·1 |
| Northampton - - | 9,113 | 6,301 | 6 | — | 929 | 164 | 1,713 | 20·6 | 4,087 | 8·8 |
| Northumberland - | 15,746 | 13,295 | 20 | — | 1,578 | 387 | 466 | 5·4 | 2,655 | 3·3 |
| Nottingham - - | 16,511 | 13,221 | 27 | — | 1,669 | 227 | 1,367 | 9·7 | 6,258 | 7·1 |
| Oxford - - - | 5,441 | 4,523 | 6 | — | 459 | 89 | 364 | 8·3 | 1,643 | 5·9 |

| — | Returns, 1888. | | | | | | | | Children remaining "unaccounted for" when the Returns for the several Years were received. | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Births. | Successfully Vaccinated. | Insusceptible of Vaccination. | Had Small-pox. | Died unvaccinated. | Vaccination postponed. | Remaining. | Children not finally accounted for (including cases postponed), per cent. of births. | Total Number for the Years 1883-87. | Average Per-centage for the Years 1883-87. |
| COUNTIES—*cont.* | | | | | | | | | | |
| ENGLAND—*cont.* | | | | | | | | | | |
| Rutland | 554 | 488 | 1 | — | 46 | 5 | 14 | 3·4 | 114 | 3·5 |
| Salop | 7,206 | 6,319 | 6 | — | 608 | 84 | 189 | 3·8 | 1,234 | 3·3 |
| Somerset | 14,447 | 12,258 | 32 | — | 1,177 | 278 | 702 | 6·8 | 3,171 | 4·3 |
| Southampton | 18,685 | 16,165 | 33 | — | 1,388 | 303 | 796 | 5·9 | 4,239 | 4·6 |
| Stafford | 31,965 | 26,564 | 60 | — | 3,570 | 330 | 1,441 | 5·5 | 6,539 | 3·9 |
| Suffolk | 10,992 | 9,489 | 16 | — | 935 | 194 | 358 | 5·0 | 2,468 | 4·4 |
| Surrey (extra-metro.) | 14,718 | 12,409 | 25 | — | 1,108 | 277 | 899 | 8·0 | 3,828 | 5·2 |
| Sussex | 13,943 | 11,623 | 33 | — | 1,048 | 251 | 988 | 8·9 | 4,359 | 5·9 |
| Warwick | 23,881 | 19,948 | 40 | 1 | 2,434 | 222 | 1,236 | 6·1 | 5,941 | 4·8 |
| Westmorland | 1,832 | 1,664 | 4 | — | 123 | 20 | 21 | 2·2 | 129 | 1·4 |
| Wilts | 7,234 | 6,312 | 5 | — | 546 | 182 | 189 | 5·1 | 1,328 | 3·6 |
| Worcester | 17,780 | 15,515 | 18 | — | 1,646 | 177 | 424 | 3·4 | 2,388 | 2·6 |
| York, East Riding | 12,226 | 10,230 | 35 | — | 1,173 | 101 | 687 | 6·4 | 4,458 | 7·0 |
| York, North Riding | 10,953 | 9,192 | 16 | — | 1,089 | 253 | 403 | 6·0 | 2,288 | 3·9 |
| York, West Riding | 72,774 | 55,669 | 224 | 7 | 7,986 | 748 | 8,140 | 12·2 | 31,915 | 8·6 |
| WALES: | | | | | | | | | | |
| Anglesey | 854 | 720 | — | — | 89 | 9 | 36 | 5·2 | 129 | 2·8 |
| Brecknock | 1,561 | 1,346 | — | — | 153 | 14 | 48 | 4·0 | 231 | 2·9 |
| Cardigan | 1,737 | 1,555 | — | — | 131 | 17 | 34 | 2·9 | 285 | 3·1 |
| Carmarthen | 4,083 | 3,681 | — | — | 339 | 30 | 33 | 1·5 | 399 | 2·0 |
| Carnarvon | 3,318 | 2,900 | 3 | — | 324 | 34 | 57 | 2·7 | 477 | 2·8 |
| Denbigh | 2,542 | 2,209 | 1 | — | 251 | 29 | 52 | 3·2 | 417 | 3·2 |
| Flint | 2,317 | 2,038 | 2 | — | 178 | 24 | 75 | 4·3 | 457 | 3·7 |
| Glamorgan | 22,672 | 19,644 | 27 | — | 2,017 | 193 | 791 | 4·3 | 3,832 | 3·6 |
| Merioneth | 1,778 | 1,551 | 2 | — | 167 | 38 | 20 | 3·3 | 324 | 3·4 |
| Montgomery | 1,910 | 1,696 | 1 | — | 152 | 20 | 41 | 3·2 | 363 | 3·6 |
| Pembroke | 2,413 | 2,037 | 1 | — | 199 | 88 | 88 | 7·3 | 629 | 4·9 |
| Radnor | 504 | 408 | — | — | 56 | 13 | 27 | 7·9 | 128 | 5·0 |

| METROPOLITAN UNIONS. | Returns, 1888. | | | | | | | | Children remaining "unaccounted for" when the Returns for the several Years were received. | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Births. | Successfully Vaccinated. | Insusceptible of Vaccination. | Had Small-pox. | Died unvaccinated. | Vaccination postponed. | Remaining. | Children not finally accounted for (including cases postponed), per cent. of births. | Total Number for the Years 1883-87. | Average Per-centage for the Years 1883-87. |
| Bethnal Green | 4,941 | 3,603 | 9 | — | 537 | 52 | 740 | 16·0 | 2,455 | 9·4 |
| Camberwell | 7,171 | 5,751 | 21 | — | 795 | 176 | 428 | 8·4 | 2,751 | 7·6 |
| Chelsea | 3,073 | 2,573 | 15 | — | 339 | 7 | 139 | 4·8 | 921 | 5·6 |
| Fulham | 5,882 | 4,980 | 43 | — | 538 | 50 | 271 | 5·5 | 1,176 | 4·3 |
| George, St., Hanover Sq. | 3,252 | 2,795 | 19 | — | 293 | 24 | 121 | 4·5 | 679 | 3·9 |
| George, St., in the East | 1,849 | 1,496 | 2 | — | 205 | 12 | 134 | 7·9 | 470 | 5·0 |
| Giles, St., and St. George | 1,233 | 891 | 5 | — | 119 | 55 | 163 | 17·7 | 820 | 12·0 |
| Greenwich | 5,228 | 4,121 | 22 | — | 557 | 123 | 405 | 10·1 | 2,759 | 10·5 |
| Hackney | 6,555 | 5,157 | 25 | — | 580 | 58 | 735 | 12·1 | 2,640 | 8·0 |
| Hampstead | 1,398 | 1,199 | 9 | — | 112 | 15 | 63 | 5·6 | 292 | 4·4 |
| Holborn | 5,298 | 4,226 | 8 | — | 520 | 47 | 497 | 10·3 | 2,306 | 8·6 |
| Islington | 9,620 | 7,522 | 39 | — | 1,112 | 219 | 728 | 9·8 | 3,960 | 8·1 |
| Kensington | 3,780 | 3,172 | 18 | — | 329 | 28 | 233 | 6·9 | 1,180 | 5·7 |
| Lambeth | 9,057 | 7,019 | 32 | — | 861 | 117 | 1,028 | 12·6 | 4,245 | 9·2 |
| Lewisham | 2,319 | 1,992 | 11 | — | 179 | 29 | 108 | 5·9 | 608 | 5·1 |
| London, City of | 788 | 658 | 2 | — | 57 | 10 | 61 | 9·0 | 251 | 5·8 |
| Marylebone | 4,481 | 3,877 | 11 | — | 375 | 41 | 177 | 4·9 | 1,326 | 5·5 |
| Mile End Old Town | 4,051 | 3,143 | 6 | 1 | 319 | 80 | 502 | 14·4 | 1,979 | 9·7 |
| Olave, St. | 4,918 | 3,706 | 12 | — | 462 | 121 | 617 | 15·0 | 2,669 | 10·4 |
| Paddington | 2,855 | 2,293 | 22 | — | 216 | 38 | 286 | 11·3 | 1,301 | 8·9 |
| Pancras, St. | 7,381 | 5,856 | 35 | — | 644 | 86 | 760 | 11·5 | 2,357 | 6·1 |
| Poplar | 6,040 | 4,507 | 32 | — | 478 | 18 | 1,005 | 16·9 | 1,318 | 4·2 |
| Saviour, St. | 7,156 | 5,166 | 8 | — | 759 | 94 | 1,129 | 17·1 | 4,106 | 11·1 |
| Shoreditch | 4,666 | 4,037 | 2 | — | 453 | 25 | 149 | 3·7 | 1,566 | 6·4 |
| Stepney | 2,084 | 1,708 | 14 | — | 227 | — | 135 | 6·5 | 456 | 4·3 |
| Strand | 601 | 464 | — | — | 77 | 13 | 47 | 10·0 | 309 | 8·8 |
| Wandsworth and Clapham | 9,164 | 7,236 | 58 | — | 819 | 180 | 871 | 11·5 | 4,072 | 9·3 |
| Westminster | 1,013 | 767 | 1 | — | 103 | 49 | 93 | 4·1 | 364 | 7·0 |
| Whitechapel | 2,632 | 2,365 | 6 | — | 206 | 3 | 52 | 2·1 | 199 | 1·6 |
| Woolwich | 3,288 | 2,915 | 7 | — | 271 | 17 | 78 | 2·9 | 289 | 1·9 |
| | 131,774 | 105,195 | 494 | 1 | 12,542 | 1,787 | 11,755 | 10·3 | 49,824 | 7·4 |

| — | Returns, 1888. | | | | | | | | Children remaining "unaccounted for" when the Returns for the several Years were received. | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Births. | Successfully Vaccinated. | Insusceptible of Vaccination. | Had Small-pox. | Died unvaccinated. | Vaccination postponed. | Remaining. | Children not finally accounted for (including cases postponed), per cent. of births. | Total Number for the Years 1883-87. | Average Per-centage for the Years 1883-87. |
| **BEDFORD.** | | | | | | | | | | |
| Ampthill | 444 | 402 | — | — | 28 | 3 | 11 | 3·2 | 63 | 2·5 |
| Bedford | 1,300 | 1,036 | 2 | — | 115 | 48 | 99 | 11·3 | 493 | 7·5 |
| Biggleswade | 796 | 650 | — | — | 72 | 14 | 60 | 9·3 | 101 | 2·3 |
| Leighton Buzzard | 608 | 527 | 5 | — | 55 | 4 | 17 | 3·5 | 102 | 3·4 |
| Luton | 1,479 | 638 | — | — | 205 | 57 | 579 | 43·0 | 1,280 | 17·0 |
| Woburn | 220 | 193 | — | — | 17 | 3 | 7 | 4·5 | 45 | 3·4 |
| **BERKS.** | | | | | | | | | | |
| Abingdon | 549 | 488 | 1 | — | 44 | 2 | 14 | 2·9 | 85 | 2·7 |
| Bradfield | 577 | 514 | 4 | — | 46 | 3 | 10 | 2·3 | 58 | 2·0 |
| Cookham | 567 | 502 | 1 | — | 35 | 22 | 7 | 5·1 | 100 | 3·6 |
| Easthampstead | 327 | 291 | — | — | 27 | — | 9 | 2·8 | 54 | 2·9 |
| Faringdon | 385 | 329 | — | — | 30 | 3 | 23 | 6·8 | 79 | 3·9 |
| Hungerford | 472 | 436 | 2 | — | 29 | 3 | 2 | 1·1 | 35 | 1·4 |
| Newbury | 581 | 474 | 3 | — | 55 | 31 | 18 | 8·4 | 198 | 6·3 |
| Reading | 1,592 | 1,267 | 7 | — | 179 | 37 | 102 | 8·7 | 501 | 6·4 |
| Wallingford | 375 | 345 | 2 | — | 21 | 6 | 1 | 1·9 | 54 | 2·7 |
| Wantage | 519 | 471 | — | — | 35 | 10 | 3 | 2·5 | 56 | 2·2 |
| Windsor | 891 | 748 | 5 | — | 68 | 7 | 63 | 7·9 | 346 | 7·2 |
| Wokingham | 584 | 497 | — | — | 50 | 12 | 25 | 6·3 | 144 | 4·6 |
| **BUCKS.** | | | | | | | | | | |
| Amersham | 609 | 545 | 1 | — | 45 | 4 | 14 | 2·9 | 52 | 1·8 |
| Aylesbury | 723 | 626 | 3 | — | 72 | 7 | 15 | 3·0 | 307 | 8·0 |
| Buckingham | 296 | 260 | — | — | 23 | 1 | 12 | 4·4 | 87 | 5·0 |
| Eton | 762 | 701 | 1 | — | 32 | 6 | 22 | 3·7 | 96 | 2·4 |
| Newport Pagnell | 805 | 706 | 5 | — | 70 | 3 | 21 | 3·0 | 108 | 2·7 |
| Winslow | 220 | 197 | — | — | 19 | — | 4 | 1·8 | 16 | 1·4 |
| Wycombe | 1,422 | 1,249 | — | — | 136 | 8 | 29 | 2·6 | 172 | 2·5 |
| **CAMBRIDGE.** | | | | | | | | | | |
| Cambridge | 971 | 847 | 1 | — | 71 | 28 | 24 | 5·4 | 177 | 3·5 |
| Caxton and Arrington | 260 | 235 | 1 | — | 18 | 1 | 5 | 2·3 | 12 | 0·8 |
| Chesterton | 832 | 748 | — | — | 62 | 8 | 14 | 2·6 | 131 | 3·0 |
| Ely | 569 | 486 | 4 | — | 46 | 15 | 18 | 5·8 | 124 | 3·9 |
| Linton | 376 | 331 | — | — | 27 | 10 | 8 | 4·8 | 58 | 2·9 |
| Newmarket | 896 | 801 | — | — | 79 | 10 | 6 | 1·8 | 58 | 1·3 |
| North Witchford | 518 | 458 | 2 | — | 46 | 6 | 6 | 2·3 | 58 | 2·3 |
| Whittlesey | 166 | 140 | — | — | 16 | — | 10 | 6·0 | 30 | 3·4 |
| Wisbech | 965 | 811 | 1 | — | 89 | 14 | 50 | 6·6 | 184 | 3·8 |
| **CHESTER.** | | | | | | | | | | |
| Altrincham | 1,646 | 1,453 | 1 | — | 132 | 31 | 29 | 3·6 | 233 | 2·7 |
| Birkenhead | 3,923 | 3,445 | 8 | — | 366 | 25 | 79 | 2·7 | 455 | 2·2 |
| Chester | 1,439 | 1,293 | 7 | — | 120 | 8 | 11 | 1·3 | 200 | 2·7 |
| Congleton | 1,106 | 989 | 1 | — | 102 | 5 | 9 | 1·3 | 98 | 1·7 |
| Macclesfield | 1,632 | 1,429 | — | — | 163 | 21 | 19 | 2·5 | 209 | 2·3 |
| Nantwich | 2,165 | 1,840 | 2 | — | 176 | 44 | 103 | 6·8 | 664 | 6·2 |
| Northwich | 1,756 | 1,600 | — | — | 132 | 6 | 18 | 1·4 | 80 | 0·9 |
| Runcorn | 1,279 | 1,165 | 1 | — | 93 | 4 | 16 | 1·5 | 66 | 1·1 |
| Stockport | 3,901 | 3,083 | 14 | — | 507 | 50 | 247 | 7·6 | 1,170 | 5·8 |
| Tarvin | 311 | 286 | — | — | 18 | 2 | 5 | 2·3 | 21 | 1·3 |
| Wirral | 977 | 847 | 2 | — | 63 | 21 | 44 | 6·7 | 202 | 4·6 |

| | Returns, 1888. | | | | | | | | Children remaining "unaccounted for" when the Returns for the several Years were received. | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Births. | Successfully Vaccinated. | Insusceptible of Vaccination. | Had Small-pox. | Died unvaccinated. | Vaccination postponed. | Remaining. | Children not finally accounted for (including cases postponed), per cent. of births. | Total Number for the Years 1883–87. | Average Per-centage for the Years 1883–87. |
| **CORNWALL.** | | | | | | | | | | |
| Austell, St. | 925 | 830 | 1 | — | 72 | 14 | 8 | 2·4 | 84 | 1·8 |
| Bodmin | 504 | 449 | — | — | 40 | 8 | 7 | 3·0 | 28 | 1·1 |
| Camelford | 197 | 177 | — | — | 13 | 6 | 1 | 3·6 | 15 | 1·5 |
| Columb, St., Major | 429 | 379 | 4 | — | 33 | 4 | 9 | 3·0 | 54 | 2·4 |
| Falmouth | 575 | 361 | — | — | 57 | 8 | 149 | 27·3 | 247 | 7·8 |
| Germans, St. | 441 | 386 | — | — | 40 | 7 | 8 | 3·4 | 61 | 2·6 |
| Helston | 637 | 528 | — | — | 73 | 14 | 22 | 5·7 | 136 | 4·0 |
| Launceston | 440 | 397 | — | — | 26 | 3 | 4 | 1·6 | 27 | 1·2 |
| Liskeard | 740 | 648 | 1 | — | 62 | 13 | 16 | 3·9 | 148 | 3·1 |
| Penzance | 1,478 | 1,239 | — | — | 148 | 14 | 77 | 6·2 | 241 | 3·3 |
| Redruth | 1,518 | 1,216 | — | — | 215 | 38 | 49 | 5·7 | 310 | 4·1 |
| Stratton | 187 | 159 | — | — | 16 | 5 | 7 | 6·4 | 24 | 2·3 |
| Truro | 827 | 694 | — | — | 55 | 44 | 34 | 9·4 | 352 | 7·3 |
| **CUMBERLAND.** | | | | | | | | | | |
| Alston-with-Garrigill | 88 | 75 | — | — | 10 | 3 | — | 3·4 | 12 | 2·4 |
| Bootle | 484 | 457 | — | — | 26 | — | 1 | 0·2 | 51 | 2·1 |
| Brampton | 268 | 220 | — | — | 27 | 13 | 8 | 7·8 | 57 | 4·1 |
| Carlisle | 1,684 | 1,491 | — | — | 134 | 31 | 28 | 3·5 | 255 | 3·0 |
| Cockermouth | 2,409 | 2,013 | 1 | — | 256 | 61 | 78 | 5·8 | 622 | 5·2 |
| Longtown | 214 | 197 | — | — | 16 | 1 | — | 0·5 | 21 | 2·0 |
| Penrith | 637 | 585 | 1 | — | 42 | 3 | 6 | 1·4 | 34 | 1·0 |
| Whitehaven | 2,036 | 1,784 | — | — | 170 | 13 | 69 | 4·0 | 541 | 5·0 |
| Wigton | 716 | 613 | — | — | 60 | 3 | 40 | 6·0 | 140 | 4·1 |
| **DERBY.** | | | | | | | | | | |
| Ashbourne | 598 | 523 | — | — | 54 | 1 | 20 | 3·5 | 106 | 3·6 |
| Bakewell | 820 | 702 | 1 | — | 63 | 27 | 27 | 6·6 | 178 | 4·1 |
| Belper | 1,979 | 1,799 | 2 | — | 157 | 3 | 18 | 1·1 | 115 | 1·1 |
| Chapel-en-le-Frith | 607 | 524 | 2 | — | 50 | 12 | 19 | 5·1 | 95 | 3·1 |
| Chesterfield | 3,572 | 2,820 | — | — | 341 | 52 | 359 | 11·5 | 1,090 | 5·8 |
| Derby | 2,720 | 2,186 | 8 | — | 306 | 39 | 181 | 8·1 | 2,194 | 15·4 |
| Glossop | 779 | 615 | 4 | — | 105 | 2 | 53 | 7·1 | 244 | 6·2 |
| Hayfield | 356 | 316 | 2 | — | 27 | 6 | 5 | 3·1 | 49 | 2·7 |
| Shardlow | 1,783 | 1,579 | 4 | — | 131 | 18 | 51 | 3·9 | 440 | 4·9 |
| **DEVON.** | | | | | | | | | | |
| Axminster | 470 | 425 | 1 | — | 31 | 4 | 9 | 2·8 | 118 | 4·9 |
| Barnstaple | 1,151 | 1,003 | 1 | — | 95 | 27 | 25 | 4·5 | 141 | 2·6 |
| Bideford | 564 | 502 | 1 | — | 45 | 12 | 4 | 2·8 | 47 | 1·6 |
| Crediton | 474 | 444 | — | — | 21 | 1 | 8 | 1·9 | 43 | 1·7 |
| East Stonehouse | 559 | 455 | 1 | — | 72 | 14 | 17 | 5·5 | 137 | 4·9 |
| Exeter | 959 | 754 | — | — | 107 | 40 | 58 | 10·2 | 278 | 5·2 |
| Holsworthy | 249 | 225 | — | — | 20 | 1 | 3 | 1·6 | 19 | 1·4 |
| Honiton | 537 | 478 | 3 | — | 38 | 12 | 6 | 3·4 | 123 | 4·0 |
| Kingsbridge | 467 | 424 | — | — | 31 | 3 | 9 | 2·6 | 30 | 1·2 |
| Newton Abbot | 1,889 | 1,719 | 1 | — | 124 | 9 | 36 | 2·4 | 153 | 1·6 |
| Okehampton | 442 | 396 | — | — | 29 | 4 | 13 | 3·8 | 83 | 3·4 |
| Plymouth | 2,469 | 1,939 | 7 | — | 281 | 60 | 182 | 9·8 | 798 | 6·7 |
| Plympton St. Mary | 651 | 556 | — | — | 51 | 16 | 28 | 6·8 | 173 | 5·3 |
| Southmolton | 423 | 380 | 1 | — | 31 | 6 | 5 | 2·6 | 57 | 2·4 |
| Stoke Damerel | 1,624 | 1,281 | 6 | — | 152 | 56 | 129 | 11·4 | 598 | 7·5 |
| Tavistock | 792 | 702 | — | — | 68 | 7 | 15 | 2·8 | 31 | 0·8 |
| Thomas, St. | 1,372 | 1,142 | 1 | — | 118 | 44 | 67 | 8·1 | 351 | 5·0 |
| Tiverton | 802 | 729 | 1 | — | 46 | 7 | 19 | 3·2 | 108 | 2·4 |
| Torrington | 397 | 350 | — | — | 33 | 9 | 5 | 3·5 | 61 | 3·0 |
| Totnes | 1,105 | 992 | — | — | 80 | 7 | 26 | 3·0 | 91 | 1·6 |

| | Returns, 1888. | | | | | | | | Children remaining "unaccounted for" when the Returns for the several Years were received. | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Births. | Successfully Vaccinated. | Insusceptible of Vaccination. | Had Small-pox. | Died unvaccinated. | Vaccination postponed. | Remaining. | Children not finally accounted for (including cases postponed), per cent. of births. | Total Number for the Years 1883-87. | Average Per-centage for the Years 1883-87. |
| **DORSET.** | | | | | | | | | | |
| Beaminster | 305 | 267 | — | — | 29 | 6 | 3 | 3·0 | 36 | 2·2 |
| Blandford | 317 | 258 | — | — | 22 | 8 | 29 | 11·7 | 187 | 10·8 |
| Bridport | 423 | 398 | — | — | 15 | 7 | 3 | 2·4 | 82 | 3·9 |
| Cerne | 176 | 162 | — | — | 14 | — | — | 0·0 | 10 | 1·1 |
| Dorchester | 491 | 440 | 1 | — | 34 | 5 | 11 | 3·3 | 73 | 2·8 |
| Poole | 711 | 630 | 1 | — | 48 | 14 | 18 | 4·5 | 122 | 3·4 |
| Shaftesbury | 307 | 254 | 1 | — | 22 | 5 | 25 | 9·8 | 79 | 4·5 |
| Sherborne | 324 | 295 | — | — | 20 | — | 9 | 2·8 | 40 | 2·3 |
| Sturminster | 285 | 256 | — | — | 17 | 7 | 5 | 4·2 | 44 | 3·0 |
| Wareham and Purbeck | 489 | 439 | — | — | 34 | 5 | 11 | 3·3 | 66 | 2·5 |
| Weymouth | 763 | 581 | — | — | 70 | 16 | 96 | 14·7 | 335 | 8·3 |
| Wimborne and Cranborne | 541 | 483 | — | — | 36 | 8 | 14 | 4·1 | 113 | 4·3 |
| **DURHAM.** | | | | | | | | | | |
| Auckland | 3,108 | 2,602 | 1 | — | 313 | 53 | 139 | 6·2 | 747 | 4·5 |
| Chester-le-Street | 1,825 | 1,487 | 1 | — | 247 | 23 | 67 | 4·9 | 408 | 4·4 |
| Darlington | 1,489 | 1,235 | 2 | — | 150 | 8 | 94 | 6·8 | 361 | 4·5 |
| Durham | 2,415 | 2,079 | 4 | — | 232 | 32 | 68 | 4·1 | 493 | 4·0 |
| Easington | 1,849 | 1,581 | 3 | — | 190 | 26 | 49 | 4·1 | 620 | 7·0 |
| Gateshead | 4,597 | 3,777 | 6 | — | 504 | 68 | 242 | 6·7 | 1,221 | 5·4 |
| Hartlepool | 2,170 | 1,861 | 2 | — | 213 | 44 | 50 | 4·3 | 464 | 4·3 |
| Houghton-le-Spring | 1,481 | 1,265 | 4 | — | 158 | 6 | 48 | 3·6 | 191 | 2·5 |
| Lanchester | 2,242 | 1,936 | 2 | — | 203 | 21 | 80 | 4·5 | 344 | 3·0 |
| Sedgefield | 701 | 608 | — | — | 67 | 11 | 15 | 3·7 | 126 | 3·7 |
| South Shields | 4,767 | 3,275 | 3 | — | 389 | 92 | 1,008 | 23·1 | 2,851 | 11·9 |
| Stockton | 1,970 | 1,673 | 2 | — | 116 | 28 | 151 | 9·1 | 766 | 7·6 |
| Sunderland | 5,588 | 4,830 | 5 | — | 489 | 35 | 229 | 4·7 | 1,090 | 3·7 |
| Teesdale | 580 | 474 | — | — | 64 | 14 | 28 | 7·2 | 112 | 3·7 |
| Weardale | 481 | 427 | — | — | 41 | 3 | 10 | 2·7 | 62 | 2·3 |
| **ESSEX** | | | | | | | | | | |
| Billericay | 516 | 439 | — | — | 34 | 14 | 29 | 8·3 | 137 | 5·4 |
| Braintree | 744 | 659 | — | — | 53 | 15 | 17 | 4·3 | 114 | 2·8 |
| Chelmsford | 933 | 829 | — | — | 52 | 18 | 34 | 5·6 | 138 | 2·8 |
| Colchester | 980 | 797 | — | — | 78 | 17 | 88 | 10·7 | 343 | 7·3 |
| Dunmow | 491 | 446 | — | — | 25 | 8 | 12 | 4·1 | 69 | 2·9 |
| Epping | 688 | 589 | 6 | — | 58 | 7 | 28 | 5·1 | 137 | 4·0 |
| Halstead | 458 | 403 | — | — | 40 | 5 | 10 | 3·3 | 68 | 2·9 |
| Lexden and Winstree | 593 | 528 | 1 | — | 50 | 4 | 10 | 2·4 | 44 | 1·4 |
| Maldon | 739 | 646 | 2 | — | 51 | 6 | 34 | 5·4 | 113 | 3·2 |
| Ongar | 278 | 239 | — | — | 23 | 4 | 12 | 5·8 | 61 | 4·1 |
| Orsett | 933 | 760 | 2 | — | 70 | 35 | 66 | 10·8 | 311 | 7·3 |
| Rochford | 889 | 769 | 1 | — | 67 | 16 | 36 | 5·8 | 170 | 4·1 |
| Romford | 1,600 | 1,319 | 2 | — | 124 | 25 | 130 | 9·7 | 454 | 6·0 |
| Saffron Walden | 508 | 456 | — | — | 34 | 3 | 15 | 3·5 | 67 | 2·5 |
| Tendring | 1,136 | 991 | 3 | — | 105 | 14 | 23 | 3·3 | 121 | 2·2 |
| West Ham | 11,500 | 9,110 | 43 | — | 945 | 280 | 1,122 | 12·2 | 5,310 | 10·1 |
| **GLOUCESTER.** | | | | | | | | | | |
| Barton Regis | 5,630 | 4,799 | 32 | — | 497 | 82 | 220 | 5·4 | 974 | 3·5 |
| Bristol | 1,682 | 1,411 | 13 | — | 166 | 14 | 78 | 5·5 | 391 | 4·6 |
| Cheltenham | 1,330 | 914 | 1 | — | 146 | 78 | 191 | 20·2 | 966 | 13·8 |
| Chipping Sodbury | 455 | 387 | 3 | — | 34 | 11 | 20 | 6·8 | 94 | 3·7 |
| Cirencester | 555 | 485 | — | — | 39 | 8 | 23 | 5·6 | 140 | 4·8 |
| Dursley | 335 | 281 | 1 | — | 20 | 8 | 25 | 9·9 | 100 | 5·7 |
| Gloucester | 1,438 | 140 | — | — | 157 | 5 | 1,136 | 79·3 | 1,526 | 20·5 |
| Newent | 265 | 238 | — | — | 11 | 4 | 12 | 6·0 | 49 | 3·1 |
| Northleach | 227 | 208 | 1 | — | 10 | — | 8 | 3·5 | 40 | 3·3 |

| — | Returns, 1888. | | | | | | | | Children remaining "unaccounted for" when the Returns for the several Years were received. | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Births. | Successfully Vaccinated. | Insusceptible of Vaccination. | Had Small-pox. | Died unvaccinated. | Vaccination postponed. | Remaining. | Children not finally accounted for (including cases postponed), per cent. of births. | Total Number for the Years 1883-87. | Average Per-centage for the Years 1883-87. |
| **GLOUCESTER—*cont.*** | | | | | | | | | | |
| Stow-on-the-Wold | 274 | 211 | 2 | — | 30 | 7 | 24 | 11·3 | 58 | 4·3 |
| Stroud | 1,144 | 990 | 1 | — | 92 | 22 | 39 | 5·3 | 157 | 2·6 |
| Tetbury | 128 | 114 | — | — | 6 | 3 | 5 | 6·2 | 41 | 5·0 |
| Tewkesbury | 387 | 334 | 3 | — | 29 | 6 | 15 | 5·4 | 66 | 3·5 |
| Thornbury | 494 | 447 | — | — | 30 | 6 | 11 | 3·4 | 120 | 4·3 |
| Westbury-on-Severn | 850 | 631 | 3 | — | 87 | 65 | 64 | 15·2 | 235 | 5·7 |
| Wheatenhurst | 197 | 144 | — | — | 16 | 24 | 13 | 18·8 | 42 | 4·4 |
| Winchcomb | 234 | 212 | — | — | 17 | 3 | 2 | 2·1 | 42 | 3·2 |
| **HEREFORD.** | | | | | | | | | | |
| Bromyard | 307 | 265 | — | — | 30 | 4 | 8 | 3·9 | 70 | 4·6 |
| Dore | 233 | 196 | — | — | 21 | 8 | 8 | 6·9 | 55 | 5·1 |
| Hereford | 963 | 840 | 1 | — | 74 | 8 | 40 | 5·0 | 174 | 3·7 |
| Kington | 331 | 282 | 1 | — | 28 | 10 | 10 | 6·0 | 42 | 2·6 |
| Ledbury | 322 | 286 | 1 | — | 22 | 2 | 11 | 4·0 | 65 | 4·0 |
| Leominster | 343 | 303 | — | — | 24 | 8 | 8 | 4·7 | 105 | 5·6 |
| Ross | 445 | 395 | 3 | — | 29 | 3 | 15 | 4·0 | 51 | 2·3 |
| Weobley | 234 | 209 | — | — | 9 | 5 | 11 | 6·8 | 48 | 4·3 |
| **HERTS.** | | | | | | | | | | |
| Albans, St. | 797 | 630 | 2 | — | 73 | 6 | 86 | 11·5 | 180 | 4·5 |
| Barnet | 1,215 | 925 | 5 | — | 123 | 48 | 114 | 13·3 | 449 | 7·8 |
| Berkhampstead | 457 | 410 | — | — | 38 | 2 | 7 | 2·0 | 54 | 2·2 |
| Bishop's Stortford | 563 | 502 | — | — | 43 | 6 | 12 | 3·2 | 49 | 1·6 |
| Buntingford | 158 | 148 | — | — | 7 | 1 | 2 | 1·9 | 18 | 2·3 |
| Hatfield | 209 | 186 | — | — | 9 | 4 | 10 | 6·7 | 36 | 3·4 |
| Hemel Hempstead | 431 | 371 | 2 | — | 38 | 1 | 19 | 4·6 | 72 | 3·1 |
| Hertford | 453 | 393 | — | — | 37 | 3 | 20 | 5·1 | 61 | 2·6 |
| Hitchin | 804 | 736 | 3 | — | 49 | 4 | 12 | 2·0 | 85 | 1·9 |
| Royston | 461 | 397 | — | — | 39 | 15 | 10 | 5·4 | 61 | 2·3 |
| Ware | 532 | 456 | — | — | 54 | 2 | 20 | 4·1 | 76 | 2·7 |
| Watford | 976 | 879 | 1 | — | 66 | 12 | 18 | 3·1 | 173 | 3·7 |
| Welwyn | 62 | 60 | — | — | 2 | — | — | 0·0 | 6 | 1·9 |
| **HUNTINGDON.** | | | | | | | | | | |
| Huntingdon | 516 | 450 | — | — | 47 | 8 | 11 | 3·7 | 45 | 1·6 |
| Ives, St. | 478 | 432 | 1 | — | 34 | 5 | 6 | 2·3 | 43 | 1·9 |
| Neots, St. | 418 | 386 | — | — | 27 | — | 5 | 1·2 | 48 | 2·0 |
| **KENT (Extra-Metropolitan).** | | | | | | | | | | |
| Ashford, East | 444 | 406 | — | — | 33 | 2 | 3 | 1·1 | 51 | 2·3 |
| Ashford, West | 573 | 501 | 1 | — | 33 | 16 | 22 | 6·6 | 133 | 4·5 |
| Blean | 555 | 508 | — | — | 27 | 4 | 16 | 6·6 | 80 | 2·8 |
| Bridge | 365 | 336 | — | — | 19 | 3 | 7 | 2·7 | 41 | 2·3 |
| Bromley | 1,899 | 1,575 | 7 | — | 166 | 86 | 65 | 8·0 | 405 | 4·5 |
| Canterbury | 518 | 456 | 1 | — | 35 | 6 | 20 | 5·0 | 90 | 3·4 |
| Cranbrook | 339 | 308 | 1 | — | 18 | 1 | 11 | 3·5 | 55 | 2·8 |
| Dartford | 1,870 | 1,590 | 5 | — | 144 | 40 | 91 | 7·0 | 485 | 5·3 |
| Dover | 1,129 | 795 | 2 | — | 88 | 29 | 215 | 21·6 | 753 | 13·1 |
| Eastry | 806 | 726 | — | — | 61 | 5 | 14 | 2·4 | 87 | 2·1 |
| Elham | 1,109 | 943 | 1 | — | 85 | 17 | 63 | 7·2 | 287 | 5·4 |
| Faversham | 863 | 765 | 1 | — | 78 | 3 | 16 | 2·2 | 56 | 1·2 |
| Gravesend and Milton | 659 | 509 | 4 | — | 39 | — | 107 | 16·2 | 441 | 11·2 |
| Hollingbourn | 426 | 381 | — | — | 32 | 3 | 10 | 3·1 | 74 | 3·4 |
| Hoo | 146 | 117 | — | — | 15 | — | 14 | 9·6 | 25 | 3·7 |
| Maidstone | 1,399 | 1,139 | 1 | — | 145 | 8 | 106 | 8·1 | 606 | 8·0 |

| | Returns, 1888. | | | | | | | | Children remaining "unaccounted for" when the Returns for the several Years were received. | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Births. | Successfully Vaccinated. | Insusceptible of Vaccination. | Had Small-pox. | Died unvaccinated. | Vaccination postponed. | Remaining. | Children not finally accounted for (including cases postponed), per cent. of births. | Total Number for the Years 1883-87. | Average Per-centage for the Years 1883-87. |
| **KENT (Extra-Metropolitan)—*cont.*** | | | | | | | | | | |
| Malling | 862 | 743 | — | — | 78 | 13 | 28 | 4·8 | 154 | 3·3 |
| Medway | 2,239 | 1,912 | 3 | — | 201 | 43 | 80 | 5·5 | 367 | 3·2 |
| Milton | 891 | 763 | 1 | — | 85 | 22 | 20 | 4·7 | 100 | 2·2 |
| Romney Marsh | 188 | 176 | — | — | 11 | 1 | — | 0·5 | 7 | 0·7 |
| Sevenoaks | 832 | 729 | — | — | 56 | 11 | 36 | 5·6 | 222 | 5·3 |
| Sheppey | 582 | 515 | — | — | 50 | 6 | 11 | 2·9 | 118 | 4·2 |
| Strood | 1,204 | 1,041 | 1 | — | 104 | 12 | 46 | 4·8 | 169 | 3·0 |
| Tenterden | 287 | 253 | 1 | — | 22 | 4 | 7 | 3·8 | 31 | 2·0 |
| Thanet, Isle of | 1,486 | 1,308 | 1 | — | 110 | 25 | 42 | 4·5 | 153 | 2·1 |
| Tonbridge | 1,545 | 1,278 | — | — | 112 | 29 | 126 | 10·0 | 389 | 5·1 |
| **LANCASTER.** | | | | | | | | | | |
| Ashton-under-Lyne | 5,019 | 3,992 | 19 | — | 580 | 26 | 402 | 8·5 | 1,579 | 5·9 |
| Barrow-in-Furness | 1,456 | 1,311 | 2 | — | 114 | 10 | 19 | 2·0 | 265 | 2·9 |
| Barton-upon-Irwell | 2,484 | 2,041 | 5 | — | 240 | 55 | 143 | 8·0 | 841 | 6·6 |
| Blackburn | 6,712 | 5,759 | 25 | 1 | 710 | 41 | 176 | 3·2 | 805 | 2·4 |
| Bolton | 7,172 | 6,465 | 9 | — | 613 | 15 | 70 | 1·2 | 359 | 1·0 |
| Burnley | 5,392 | 3,648 | 7 | — | 690 | 4 | 1,043 | 19·4 | 2,288 | 9·1 |
| Bury | 4,159 | 3,678 | 14 | — | 381 | 16 | 70 | 2·1 | 369 | 1·7 |
| Chorley | 1,777 | 1,526 | 3 | — | 189 | 4 | 55 | 3·3 | 380 | 4·4 |
| Chorlton | 9,246 | 7,409 | 17 | — | 1,021 | 174 | 625 | 8·6 | 3,539 | 7·7 |
| Clitheroe | 675 | 555 | 1 | — | 74 | 23 | 22 | 6·7 | 134 | 4·1 |
| Fylde, The | 1,442 | 1,243 | 3 | 1 | 144 | 21 | 30 | 3·5 | 212 | 3·0 |
| Garstang | 306 | 277 | — | — | 25 | — | 4 | 1·3 | 56 | 3·3 |
| Haslingden | 3,036 | 2,571 | 3 | — | 293 | 24 | 145 | 5·6 | 335 | 2·2 |
| Lancaster | 1,364 | 1,183 | 3 | — | 132 | 12 | 34 | 3·4 | 207 | 2·9 |
| Leigh | 2,500 | 2,173 | 2 | — | 237 | 2 | 86 | 3·5 | 343 | 2·9 |
| Liverpool | 5,455 | 4,545 | 11 | — | 652 | 13 | 234 | 4·5 | 1,418 | 4·7 |
| Lunesdale | 193 | 177 | — | — | 14 | 1 | 1 | 1·0 | 14 | 1·3 |
| Manchester | 5,127 | 4,298 | 7 | — | 621 | 51 | 150 | 3·9 | 983 | 3·7 |
| Oldham | 6,348 | 1,583 | 18 | — | 883 | 62 | 3,802 | 60·9 | 7,875 | 24·5 |
| Ormskirk | 2,613 | 2,273 | 3 | — | 211 | 35 | 91 | 4·8 | 426 | 3·2 |
| Prescot | 5,069 | 4,188 | 10 | — | 587 | 72 | 212 | 5·6 | 1,190 | 4·9 |
| Preston | 4,884 | 3,773 | 19 | 1 | 648 | 26 | 417 | 9·1 | 1,731 | 7·1 |
| Prestwich | 4,793 | 3,880 | 7 | — | 427 | 91 | 388 | 10·0 | 1,682 | 7·1 |
| Rochdale | 3,236 | 2,780 | 11 | — | 318 | 29 | 98 | 3·9 | 626 | 3·7 |
| Salford | 7,373 | 5,650 | 35 | — | 905 | 193 | 590 | 10·6 | 2,715 | 7·5 |
| Todmorden | 995 | 849 | 2 | — | 92 | 2 | 50 | 5·2 | 181 | 3·7 |
| Toxteth Park | 4,175 | 3,233 | 16 | — | 406 | 122 | 398 | 12·5 | 2,162 | 9·4 |
| Ulverston | 1,420 | 1,265 | 3 | — | 97 | 31 | 24 | 3·9 | 258 | 3·3 |
| Warrington | 2,973 | 2,484 | 1 | — | 298 | 26 | 164 | 6·4 | 679 | 4·6 |
| West Derby | 14,760 | 12,614 | 29 | — | 1,306 | 117 | 694 | 5·5 | 4,395 | 5·8 |
| Wigan | 6,356 | 5,490 | 4 | — | 606 | 96 | 160 | 4·0 | 751 | 2·4 |
| **LEICESTER.** | | | | | | | | | | |
| Ashby-de-la-Zouch | 1,176 | 964 | 1 | — | 146 | 4 | 61 | 5·5 | 271 | 4·6 |
| Barrow-on-Soar | 1,037 | 556 | 2 | — | 110 | 34 | 335 | 35·6 | 982 | 18·5 |
| Billesdon | 413 | 240 | 1 | — | 42 | 4 | 126 | 31·5 | 260 | 16·2 |
| Blaby | 1,145 | 802 | 1 | — | 117 | 9 | 216 | 19·7 | 556 | 11·4 |
| Hinckley | 726 | 608 | — | — | 78 | 4 | 36 | 5·5 | 75 | 2·2 |
| Leicester | 4,805 | 220 | — | — | 885 | — | 3,700 | 77·0 | 13,619 | 56·9 |
| Loughborough | 960 | 768 | 2 | — | 93 | 41 | 56 | 10·1 | 280 | 5·7 |
| Lutterworth | 291 | 263 | — | — | 19 | 5 | 4 | 3·1 | 32 | 1·9 |
| Market Bosworth | 495 | 411 | 1 | — | 53 | 14 | 16 | 6·1 | 87 | 3·4 |
| Market Harborough | 431 | 378 | — | — | 31 | 4 | 18 | 5·1 | 103 | 4·3 |
| Melton Mowbray | 648 | 573 | 1 | — | 47 | 2 | 25 | 4·1 | 119 | 3·7 |

| — | Returns, 1888. | | | | | | | | Children remaining "unaccounted for" when the Returns for the several Years were received. | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Births. | Successfully Vaccinated. | Insusceptible of Vaccination. | Had Small-pox. | Died unvaccinated. | Vaccination postponed. | Remaining. | Children not finally accounted for (including cases postponed), per cent. of births. | Total Number for the Years 1883-87. | Average Per-centage for the Years 1883-87. |
| **LINCOLN.** | | | | | | | | | | |
| Boston | 1,049 | 912 | — | — | 84 | 15 | 38 | 5·1 | 334 | 5·9 |
| Bourn | 548 | 451 | — | — | 60 | 15 | 22 | 6·8 | 160 | 5·7 |
| Caistor | 2,575 | 2,050 | 12 | — | 385 | 54 | 74 | 5·0 | 688 | 5·6 |
| Gainsborough | 1,028 | 882 | 2 | — | 105 | 3 | 36 | 3·8 | 470 | 8·8 |
| Glanford Brigg | 1,212 | 1,059 | 2 | — | 112 | 8 | 31 | 3·2 | 207 | 3·0 |
| Grantham | 983 | 866 | 2 | — | 87 | 7 | 21 | 2·8 | 169 | 3·2 |
| Holbeach | 508 | 428 | 2 | — | 53 | 11 | 14 | 4·9 | 161 | 5·7 |
| Horncastle | 565 | 484 | — | — | 48 | 9 | 24 | 5·9 | 62 | 2·1 |
| Lincoln | 1,776 | 1,428 | 5 | — | 226 | 42 | 75 | 6·6 | 822 | 7·7 |
| Louth | 823 | 713 | 1 | — | 67 | 16 | 26 | 5·1 | 237 | 5·3 |
| Sleaford | 678 | 596 | — | — | 48 | 9 | 25 | 5·0 | 69 | 2·6 |
| Spalding | 576 | 500 | — | — | 41 | 8 | 27 | 6·1 | 124 | 3·7 |
| Spilsby | 681 | 592 | — | — | 64 | 10 | 15 | 3·7 | 131 | 3·4 |
| Stamford | 439 | 378 | 1 | — | 36 | 8 | 16 | 5·5 | 131 | 5·4 |
| **MIDDLESEX (Extra-Metropolitan).** | | | | | | | | | | |
| Brentford | 3,752 | 3,132 | 7 | — | 341 | 10 | 262 | 7·2 | 1,337 | 7·2 |
| Edmonton | 6,986 | 5,680 | 30 | — | 516 | 131 | 629 | 10·9 | 2,773 | 8·6 |
| Hendon | 2,732 | 2,114 | 8 | — | 237 | 41 | 332 | 13·7 | 1,679 | 14·0 |
| Staines | 716 | 607 | 1 | — | 60 | 17 | 31 | 6·7 | 240 | 6·5 |
| Uxbridge | 893 | 798 | 2 | — | 57 | 10 | 26 | 4·0 | 141 | 3·1 |
| **MONMOUTH.** | | | | | | | | | | |
| Abergavenny | 727 | 635 | — | — | 66 | 17 | 9 | 3·6 | 80 | 2·0 |
| Bedwellty | 2,157 | 1,773 | 3 | — | 232 | 56 | 93 | 6·9 | 520 | 4·6 |
| Chepstow | 553 | 483 | 1 | — | 37 | 17 | 15 | 5·8 | 127 | 4·1 |
| Monmouth | 753 | 662 | 1 | — | 50 | 19 | 21 | 5·3 | 113 | 2·6 |
| Newport | 3,265 | 2,816 | 6 | — | 283 | 39 | 121 | 4·9 | 509 | 3·3 |
| Pontypool | 1,221 | 1,054 | 1 | — | 109 | 11 | 46 | 4·7 | 326 | 5·1 |
| **NORFOLK.** | | | | | | | | | | |
| Aylsham | 515 | 461 | 1 | — | 41 | 5 | 7 | 2·3 | 58 | 2·2 |
| Blofield | 368 | 330 | — | — | 28 | 7 | 3 | 2·7 | 35 | 1·8 |
| Depwade | 699 | 586 | 1 | — | 70 | 26 | 16 | 6·0 | 159 | 4·6 |
| Docking | 493 | 433 | — | — | 50 | 2 | 8 | 2·0 | 70 | 2·9 |
| Downham | 566 | 486 | — | — | 59 | 3 | 18 | 3·7 | 66 | 2·1 |
| Erpingham | 557 | 454 | — | — | 50 | 24 | 29 | 9·5 | 150 | 5·4 |
| Faith, St. | 350 | 294 | — | — | 36 | 14 | 6 | 5·7 | 61 | 3·3 |
| Fleggs, East and West | 357 | 292 | 1 | — | 50 | 8 | 6 | 3·9 | 41 | 2·4 |
| Forehoe | 323 | 290 | — | — | 18 | 7 | 8 | 4·6 | 50 | 2·8 |
| Freebridge Lynn | 344 | 302 | — | — | 21 | 4 | 17 | 6·1 | 74 | 3·7 |
| Guiltcross | 294 | 269 | — | — | 18 | — | 7 | 2·4 | 44 | 2·8 |
| Henstead | 320 | 268 | 1 | — | 30 | 17 | 4 | 6·6 | 59 | 3·7 |
| King's Lynn | 616 | 503 | — | — | 66 | 20 | 27 | 7·6 | 150 | 4·8 |
| Loddon and Clavering | 405 | 355 | 1 | — | 30 | 1 | 18 | 4·7 | 56 | 2·7 |
| Mitford and Launditch | 777 | 662 | — | — | 74 | 17 | 24 | 5·3 | 92 | 2·3 |
| Norwich | 3,249 | 2,611 | 7 | — | 363 | 60 | 208 | 8·2 | 869 | 5·6 |
| Smallburgh | 508 | 425 | — | — | 55 | 7 | 21 | 5·5 | 106 | 4·2 |
| Swaffham | 371 | 320 | — | — | 25 | 4 | 22 | 7·0 | 90 | 4·8 |
| Thetford | 526 | 485 | — | — | 34 | — | 7 | 1·3 | 75 | 2·8 |
| Walsingham | 540 | 476 | — | — | 46 | 4 | 20 | 4·4 | 99 | 3·4 |
| Wayland | 336 | 305 | — | — | 25 | 4 | 2 | 1·8 | 42 | 2·6 |
| Yarmouth, Great | 1,237 | 896 | 2 | — | 150 | 38 | 151 | 15·3 | 408 | 6·6 |

| | Returns, 1888. | | | | | | | | Children remaining "unaccounted for" when the Returns for the several Years were received. | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Births. | Successfully Vaccinated. | Insusceptible of Vaccination. | Had Small-pox. | Died unvaccinated. | Vaccination postponed. | Remaining. | Children not finally accounted for (including cases postponed), per cent. of births. | Total Number for the Years 1883-87. | Average Per-centage for the Years 1883-87. |
| **NORTHAMPTON.** | | | | | | | | | | |
| Brackley | 321 | 273 | 1 | — | 28 | 2 | 17 | 5·9 | 88 | 5·1 |
| Brixworth | 334 | 306 | — | — | 17 | 2 | 9 | 3·3 | 40 | 2·2 |
| Daventry | 480 | 424 | — | — | 33 | 2 | 21 | 4·8 | 90 | 3·7 |
| Hardingstone | 325 | 268 | — | — | 37 | 7 | 13 | 6·2 | 49 | 3·0 |
| Kettering | 1,083 | 526 | 1 | — | 157 | 7 | 392 | 36·8 | 764 | 14·2 |
| Northampton | 2,456 | 1,227 | 3 | — | 317 | 51 | 858 | 37·0 | 1,813 | 15·0 |
| Oundle | 338 | 301 | — | — | 31 | 2 | 4 | 1·8 | 33 | 1·8 |
| Peterborough | 1,383 | 1,218 | — | — | 93 | 15 | 57 | 5·2 | 174 | 2·5 |
| Potterspury | 357 | 302 | — | — | 31 | 13 | 11 | 6·7 | 101 | 5·5 |
| Thrapston | 440 | 292 | — | — | 33 | 1 | 114 | 26·1 | 139 | 5·9 |
| Towcester | 314 | 270 | — | — | 25 | 10 | 9 | 6·1 | 57 | 3·1 |
| Wellingborough | 1,282 | 894 | 1 | — | 127 | 52 | 208 | 20·3 | 739 | 10·9 |
| **NORTHUMBERLAND.** | | | | | | | | | | |
| Alnwick | 691 | 596 | — | — | 53 | 20 | 22 | 6·1 | 189 | 5·7 |
| Belford | 151 | 139 | — | — | 7 | 2 | 3 | 3·3 | 7 | 1·0 |
| Bellingham | 129 | 118 | — | — | 10 | — | 1 | 0·8 | 16 | 2·3 |
| Berwick-upon-Tweed | 589 | 527 | — | — | 37 | 15 | 10 | 4·2 | 86 | 2·8 |
| Castle Ward | 659 | 577 | — | — | 54 | 2 | 26 | 4·2 | 134 | 3·9 |
| Glendale | 259 | 238 | — | — | 13 | 3 | 5 | 3·1 | 17 | 1·3 |
| Haltwhistle | 226 | 190 | — | — | 21 | 6 | 9 | 6·7 | 30 | 2·5 |
| Hexham | 925 | 792 | — | — | 79 | 13 | 41 | 5·8 | 209 | 4·1 |
| Morpeth | 1,316 | 1,033 | 1 | — | 228 | 7 | 47 | 4·1 | 176 | 2·4 |
| Newcastle-on-Tyne | 6,455 | 5,546 | 15 | — | 604 | 141 | 149 | 4·5 | 614 | 2·0 |
| Rothbury | 171 | 152 | — | — | 14 | 1 | 4 | 2·9 | 24 | 2·9 |
| Tynemouth | 4,175 | 3,387 | 4 | — | 458 | 177 | 149 | 7·8 | 1,153 | 5·1 |
| **NOTTINGHAM.** | | | | | | | | | | |
| Basford | 5,421 | 4,556 | 10 | — | 531 | 47 | 277 | 6·0 | 1,271 | 4·6 |
| Bingham | 397 | 346 | 3 | — | 24 | 9 | 15 | 6·0 | 86 | 4·3 |
| East Retford | 698 | 621 | 1 | — | 61 | 3 | 12 | 2·1 | 65 | 1·9 |
| Mansfield | 1,895 | 1,562 | — | — | 214 | 23 | 96 | 6·3 | 373 | 4·0 |
| Newark | 853 | 753 | — | — | 73 | 3 | 24 | 3·2 | 117 | 2·5 |
| Nottingham | 5,733 | 4,070 | 9 | — | 634 | 113 | 907 | 17·8 | 4,177 | 12·9 |
| Southwell | 537 | 471 | 1 | — | 46 | 7 | 12 | 3·5 | 96 | 3·6 |
| Worksop | 977 | 842 | 3 | — | 83 | 22 | 24 | 4·7 | 73 | 1·4 |
| **OXFORD.** | | | | | | | | | | |
| Banbury | 847 | 486 | — | — | 82 | 14 | 265 | 32·9 | 727 | 16·1 |
| Bicester | 408 | 353 | — | — | 30 | 14 | 11 | 6·1 | 80 | 3·8 |
| Chipping Norton | 541 | 481 | — | — | 40 | 11 | 9 | 3·7 | 116 | 4·1 |
| Headington | 978 | 879 | 3 | — | 76 | 5 | 15 | 2·0 | 103 | 2·2 |
| Henley | 642 | 560 | — | — | 55 | 10 | 17 | 4·2 | 260 | 8·5 |
| Oxford | 616 | 546 | 1 | — | 48 | 8 | 13 | 3·4 | 132 | 4·1 |
| Thame | 395 | 347 | — | — | 31 | 4 | 13 | 4·3 | 74 | 3·6 |
| Witney | 614 | 536 | — | — | 62 | 13 | 3 | 2·6 | 69 | 2·1 |
| Woodstock | 400 | 335 | 2 | — | 35 | 10 | 18 | 7·0 | 82 | 4·2 |
| **RUTLAND.** | | | | | | | | | | |
| Oakham | 262 | 237 | — | — | 18 | 3 | 4 | 2·7 | 47 | 2·9 |
| Uppingham | 292 | 251 | 1 | — | 28 | 2 | 10 | 4·1 | 67 | 4·0 |

| | Returns, 1888. | | | | | | | | Children remaining "unaccounted for" when the Returns for the several Years were received. | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Births. | Successfully Vaccinated. | Insusceptible of Vaccination. | Had Small-pox. | Died unvaccinated. | Vaccination postponed. | Remaining. | Children not finally accounted for (including cases postponed), per cent. of births. | Total Number for the Years 1883-87. | Average Per-centage for the Years 1883-87. |
| **SALOP.** | | | | | | | | | | |
| Atcham | 1,279 | 1,078 | — | — | 111 | 33 | 57 | 7·0 | 391 | 5·8 |
| Bridgnorth | 435 | 378 | — | — | 42 | 2 | 13 | 3·4 | 63 | 3·2 |
| Church Stretton | 153 | 135 | — | — | 15 | — | 3 | 2·0 | 10 | 1·5 |
| Cleobury Mortimer | 231 | 205 | — | — | 16 | 4 | 6 | 4·3 | 45 | 3·7 |
| Clun | 277 | 232 | — | — | 26 | 3 | 16 | 6·9 | 80 | 5·8 |
| Drayton | 397 | 349 | — | — | 40 | 3 | 5 | 2·0 | 28 | 1·4 |
| Ellesmere | 349 | 314 | — | — | 23 | 5 | 7 | 3·4 | 25 | 1·5 |
| Ludlow | 471 | 399 | 4 | — | 46 | 7 | 15 | 4·7 | 141 | 5·5 |
| Madeley | 709 | 643 | — | — | 49 | 3 | 14 | 2·4 | 72 | 1·9 |
| Newport | 405 | 356 | — | — | 37 | 4 | 8 | 3·0 | 53 | 2·5 |
| Oswestry | 803 | 724 | 1 | — | 62 | 4 | 12 | 2·0 | 80 | 2·0 |
| Shifnal | 352 | 314 | — | — | 30 | 1 | 7 | 2·3 | 84 | 4·5 |
| Wellington | 744 | 653 | 1 | — | 68 | 5 | 17 | 3·0 | 80 | 1·9 |
| Wem | 271 | 236 | — | — | 19 | 7 | 9 | 6·0 | 39 | 2·7 |
| Whitchurch | 330 | 303 | — | — | 24 | 3 | — | 0·9 | 43 | 2·6 |
| **SOMERSET.** | | | | | | | | | | |
| Axbridge | 1,075 | 894 | 7 | — | 79 | 37 | 58 | 8·8 | 284 | 5·1 |
| Bath | 1,881 | 1,322 | 7 | — | 172 | 84 | 296 | 20·2 | 933 | 10·3 |
| Bedminster | 2,392 | 2,052 | 8 | — | 263 | 28 | 41 | 2·9 | 411 | 3·3 |
| Bridgwater | 942 | 831 | — | — | 62 | 9 | 40 | 5·2 | 203 | 4·0 |
| Chard | 730 | 640 | — | — | 49 | 18 | 23 | 5·6 | 147 | 3·7 |
| Clutton | 799 | 693 | — | — | 75 | 6 | 25 | 3·9 | 120 | 3·0 |
| Dulverton | 136 | 131 | — | — | 3 | 1 | 1 | 1·5 | 13 | 1·9 |
| Frome | 619 | 523 | 4 | — | 57 | 1 | 34 | 5·7 | 96 | 2·9 |
| Keynsham | 881 | 783 | 1 | — | 60 | 23 | 14 | 4·2 | 186 | 4·1 |
| Langport | 441 | 398 | — | — | 28 | 2 | 13 | 3·4 | 61 | 2·9 |
| Shepton Mallet | 480 | 411 | — | — | 46 | 2 | 21 | 4·8 | 61 | 2·6 |
| Taunton | 1,067 | 899 | 2 | — | 87 | 30 | 49 | 7·4 | 172 | 3·3 |
| Wellington | 545 | 494 | — | — | 31 | 8 | 12 | 3·7 | 54 | 2·0 |
| Wells | 700 | 637 | 1 | — | 40 | 8 | 14 | 3·1 | 109 | 3·2 |
| Williton | 458 | 412 | 1 | — | 37 | 5 | 3 | 1·7 | 61 | 2·5 |
| Wincanton | 550 | 493 | 1 | — | 33 | 6 | 17 | 4·2 | 74 | 2·5 |
| Yeovil | 751 | 645 | — | — | 55 | 10 | 41 | 6·8 | 186 | 4·8 |
| **SOUTHAMPTON.** | | | | | | | | | | |
| Alresford | 188 | 165 | — | — | 13 | 5 | 5 | 5·3 | 34 | 3·6 |
| Alton | 363 | 326 | 1 | — | 26 | 2 | 8 | 2·8 | 85 | 3·8 |
| Alverstoke | 808 | 735 | 4 | — | 51 | 5 | 13 | 2·2 | 36 | 0·9 |
| Andover | 460 | 400 | — | — | 36 | 1 | 23 | 5·2 | 165 | 7·2 |
| Basingstoke | 641 | 488 | — | — | 36 | 3 | 114 | 18·3 | 282 | 8·9 |
| Catherington | 77 | 66 | — | — | 5 | 1 | 5 | 7·8 | 23 | 6·2 |
| Christchurch | 1,194 | 942 | 2 | — | 121 | 45 | 84 | 10·8 | 454 | 8·2 |
| Droxford | 280 | 247 | — | — | 18 | 10 | 5 | 5·4 | 69 | 4·2 |
| Fareham | 532 | 475 | — | — | 38 | 1 | 18 | 3·6 | 82 | 3·2 |
| Fordingbridge | 184 | 173 | — | — | 8 | — | 3 | 1·6 | 25 | 2·7 |
| Hartley Wintney | 649 | 558 | 2 | — | 43 | 12 | 34 | 7·1 | 140 | 4·8 |
| Havant | 258 | 238 | 1 | — | 16 | 2 | 1 | 1·2 | 24 | 1·8 |
| Hursley | 71 | 62 | — | — | 3 | — | 6 | 8·5 | 8 | 2·2 |
| Kingsclere | 235 | 213 | — | — | 15 | 5 | 2 | 3·0 | 27 | 2·0 |
| Lymington | 373 | 327 | — | — | 20 | 3 | 23 | 7·0 | 101 | 5·6 |
| New Forest | 400 | 356 | — | — | 20 | 7 | 17 | 6·0 | 105 | 5·4 |
| Petersfield | 326 | 287 | 1 | — | 24 | 6 | 8 | 4·3 | 64 | 4·1 |
| Portsea Island | 5,000 | 4,418 | 17 | — | 423 | 19 | 123 | 2·8 | 450 | 1·9 |
| Ringwood | 135 | 125 | — | — | 7 | 1 | 2 | 2·2 | 11 | 1·4 |
| Romsey | 316 | 282 | — | — | 21 | 6 | 7 | 4·1 | 50 | 3·1 |
| Southampton | 1,710 | 1,391 | 1 | — | 144 | 51 | 123 | 10·2 | 658 | 7·6 |
| South Stoneham | 1,425 | 1,216 | 1 | — | 93 | 37 | 78 | 8·1 | 519 | 7·2 |
| Stockbridge | 169 | 144 | — | — | 10 | 6 | 9 | 8·9 | 43 | 4·5 |
| Whitchurch | 169 | 150 | — | — | 12 | 1 | 6 | 4·1 | 47 | 5·0 |
| Wight, Isle of | 1,918 | 1,672 | 2 | — | 124 | 65 | 55 | 6·3 | 619 | 6·1 |
| Winchester, New | 804 | 709 | 1 | — | 61 | 9 | 24 | 4·1 | 118 | 2·8 |

| | Returns, 1888. | | | | | | | | Children remaining "unaccounted for" when the Returns for the several Years were received. | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Births. | Successfully Vaccinated. | Insusceptible of Vaccination. | Had Small-pox. | Died unvaccinated. | Vaccination postponed. | Remaining. | Children not finally accounted for (including cases postponed), per cent. of births. | Total Number for the Years 1883-87. | Average per-centage for the Years 1883-87. |
| **STAFFORD.** | | | | | | | | | | |
| Burton-upon-Trent | 2,739 | 2,233 | 1 | — | 265 | 44 | 196 | 8·8 | 1,019 | 7·1 |
| Cannock | 1,283 | 1,125 | 1 | — | 126 | 2 | 29 | 2·4 | 182 | 2·6 |
| Cheadle | 745 | 652 | — | — | 61 | 3 | 29 | 4·3 | 119 | 3·0 |
| Leek | 1,016 | 866 | 1 | — | 108 | 4 | 37 | 4·0 | 139 | 2·6 |
| Lichfield | 1,168 | 1,026 | 6 | — | 114 | 4 | 18 | 1·9 | 141 | 2·2 |
| Newcastle-under-Lyme | 1,250 | 1,083 | 2 | — | 113 | 11 | 41 | 4·2 | 252 | 3·9 |
| Seisdon | 467 | 418 | — | — | 36 | 2 | 11 | 2·8 | 79 | 3·2 |
| Stafford | 878 | 752 | — | — | 86 | 6 | 34 | 4·6 | 230 | 4·7 |
| Stoke-upon-Trent | 4,388 | 3,536 | 5 | — | 557 | 73 | 217 | 6·6 | 1,076 | 4·9 |
| Stone | 977 | 824 | 1 | — | 108 | 17 | 27 | 4·5 | 153 | 3·1 |
| Tamworth | 711 | 603 | — | — | 77 | 5 | 26 | 4·4 | 164 | 4·6 |
| Uttoxeter | 399 | 354 | 2 | — | 33 | 3 | 7 | 2·5 | 31 | 1·5 |
| Walsall | 3,433 | 2,619 | 12 | — | 426 | 32 | 344 | 11·0 | 1,540 | 8·8 |
| West Bromwich | 4,684 | 4,095 | 9 | — | 490 | 50 | 40 | 1·9 | 564 | 2·3 |
| Wolstanton and Burslem | 3,055 | 2,475 | 1 | — | 415 | 6 | 158 | 5·4 | 113 | 0·7 |
| Wolverhampton | 4,772 | 3,903 | 19 | — | 555 | 68 | 227 | 6·2 | 737 | 3·1 |
| **SUFFOLK.** | | | | | | | | | | |
| Blything | 728 | 647 | — | — | 49 | 13 | 19 | 4·4 | 166 | 4·1 |
| Bosmere and Claydon | 436 | 357 | 1 | — | 35 | 18 | 25 | 9·9 | 234 | 9·9 |
| Bury St. Edmunds | 467 | 403 | — | — | 38 | 12 | 14 | 5·6 | 90 | 3·8 |
| Cosford | 488 | 424 | — | — | 41 | 5 | 18 | 4·7 | 39 | 1·6 |
| Hartismere | 469 | 428 | — | — | 27 | 3 | 11 | 3·0 | 63 | 2·7 |
| Hoxne | 356 | 319 | — | — | 24 | 7 | 6 | 3·7 | 59 | 3·2 |
| Ipswich | 1,706 | 1,295 | 8 | — | 192 | 66 | 145 | 12·4 | 962 | 11·1 |
| Mildenhall | 252 | 229 | — | — | 21 | — | 2 | 0·8 | 44 | 3·2 |
| Mutford and Lothingland | 1,658 | 1,454 | 3 | — | 171 | 16 | 14 | 1·8 | 140 | 1·8 |
| Plomesgate | 597 | 516 | 1 | — | 58 | 3 | 19 | 3·7 | 137 | 4·6 |
| Risbridge | 514 | 463 | — | — | 40 | 6 | 5 | 2·1 | 59 | 2·0 |
| Samford | 335 | 301 | — | — | 21 | 4 | 9 | 3·9 | 45 | 2·6 |
| Stow | 603 | 553 | 1 | — | 40 | 4 | 5 | 1·5 | 57 | 1·9 |
| Sudbury | 865 | 759 | 1 | — | 56 | 19 | 30 | 5·7 | 145 | 3·2 |
| Thingoe | 421 | 367 | — | — | 39 | 6 | 9 | 3·6 | 60 | 2·5 |
| Wangford | 456 | 414 | 1 | — | 33 | 3 | 5 | 1·8 | 43 | 1·9 |
| Woodbridge | 641 | 560 | — | — | 50 | 9 | 22 | 4·8 | 125 | 3·8 |
| **SURREY (Extra-Metropolitan).** | | | | | | | | | | |
| Chertsey | 855 | 713 | 2 | — | 43 | 40 | 57 | 11·3 | 337 | 8·1 |
| Croydon | 3,871 | 2,993 | 6 | — | 302 | 52 | 518 | 14·7 | 1,763 | 9·0 |
| Dorking | 415 | 389 | 1 | — | 27 | 1 | 27 | 6·3 | 99 | 4·5 |
| Epsom | 1,135 | 923 | — | — | 96 | 67 | 49 | 10·2 | 514 | 8·7 |
| Farnham | 1,442 | 1,260 | 2 | — | 101 | 7 | 72 | 5·5 | 367 | 5·3 |
| Godstone | 448 | 383 | 2 | — | 37 | 3 | 23 | 5·8 | 96 | 3·9 |
| Guildford | 1,328 | 1,195 | 1 | — | 74 | 20 | 38 | 4·4 | 141 | 2·0 |
| Hambledon | 519 | 464 | — | — | 34 | 4 | 17 | 4·0 | 51 | 2·1 |
| Kingston | 2,707 | 2,348 | 8 | — | 232 | 65 | 54 | 4·4 | 258 | 1·9 |
| Reigate | 875 | 783 | 2 | — | 64 | 15 | 11 | 3·0 | 107 | 2·4 |
| Richmond | 1,093 | 958 | 1 | — | 98 | 3 | 33 | 3·3 | 101 | 1·8 |
| **SUSSEX.** | | | | | | | | | | |
| Battle | 528 | 429 | — | — | 40 | 18 | 41 | 11·2 | 142 | 5·9 |
| Brighton | 2,482 | 2,120 | 8 | — | 231 | 24 | 99 | 5·0 | 612 | 4·4 |
| Chailey | 227 | 180 | 2 | — | 24 | 6 | 15 | 9·3 | 61 | 4·6 |
| Chichester | 187 | 165 | 1 | — | 9 | 4 | 8 | 6·4 | 56 | 5·0 |
| Cuckfield | 620 | 544 | — | — | 41 | 16 | 19 | 5·6 | 157 | 4·9 |
| Eastbourne | 972 | 455 | 1 | — | 91 | 18 | 407 | 48·7 | 1,138 | 21·4 |
| East Grinstead | 528 | 454 | 1 | — | 39 | 9 | 25 | 6·4 | 138 | 5·0 |
| East Preston | 740 | 660 | 1 | — | 40 | 13 | 26 | 5·3 | 171 | 4·4 |

| | Returns, 1888. | | | | | | | | Children remaining "unaccounted for" when the Returns for the several Years were received. | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Births. | Successfully Vaccinated. | Insusceptible of Vaccination. | Had Small-pox. | Died unvaccinated. | Vaccination postponed. | Remaining. | Children not finally accounted for (including cases postponed), per cent. of births. | Total Number for the Years 1883-87. | Average Per-centage for the Years 1883-87. |
| SUSSEX—*cont.* | | | | | | | | | | |
| Hailsham | 413 | 345 | 1 | — | 39 | 6 | 22 | 6·8 | 91 | 4·1 |
| Hastings | 1,453 | 1,206 | 5 | — | 105 | 35 | 102 | 9·4 | 609 | 8·6 |
| Horsham | 676 | 584 | — | — | 49 | 9 | 34 | 6·4 | 160 | 4·5 |
| Lewes | 279 | 216 | 2 | — | 19 | 3 | 39 | 15·1 | 139 | 9·0 |
| Midhurst | 399 | 359 | 2 | — | 22 | 9 | 7 | 4·0 | 42 | 2·1 |
| Newhaven | 267 | 182 | 1 | — | 36 | 14 | 34 | 18·0 | 74 | 5·3 |
| Petworth | 240 | 216 | — | — | 16 | 5 | 3 | 3·3 | 29 | 2·1 |
| Rye | 302 | 265 | — | — | 19 | 8 | 10 | 6·0 | 51 | 2·8 |
| Steyning | 1,436 | 1,293 | 4 | — | 93 | 15 | 31 | 3·2 | 255 | 3·4 |
| Thakeham | 230 | 215 | — | — | 9 | 5 | 1 | 2·6 | 25 | 2·1 |
| Ticehurst | 461 | 404 | 2 | — | 32 | 4 | 19 | 5·0 | 106 | 4·1 |
| Uckfield | 648 | 581 | 2 | — | 36 | 10 | 19 | 4·5 | 141 | 4·3 |
| Westbourne | 204 | 190 | — | — | 10 | 2 | 2 | 2·0 | 39 | 3·6 |
| West Firle | 63 | 48 | — | — | 4 | 8 | 3 | 17·5 | 21 | 6·2 |
| Westhampnett | 588 | 512 | — | — | 44 | 10 | 22 | 5·4 | 102 | 3·5 |
| WARWICK. | | | | | | | | | | |
| Alcester | 586 | 491 | — | — | 76 | 6 | 13 | 3·2 | 82 | 2·7 |
| Aston | 8,289 | 6,647 | 18 | — | 900 | 87 | 637 | 8·7 | 2,902 | 6·9 |
| Atherstone | 521 | 451 | — | — | 56 | 6 | 8 | 2·7 | 121 | 4·5 |
| Birmingham | 8,043 | 6,825 | 16 | 1 | 805 | 27 | 369 | 4·9 | 1,549 | 3·6 |
| Coventry | 1,418 | 1,213 | — | — | 158 | 30 | 17 | 3·3 | 212 | 2·8 |
| Foleshill | 609 | 509 | — | — | 67 | 7 | 26 | 5·4 | 190 | 6·0 |
| Meriden | 259 | 234 | — | — | 18 | 5 | 2 | 2·7 | 47 | 3·3 |
| Nuneaton | 514 | 425 | — | — | 64 | 3 | 22 | 4·9 | 101 | 4·1 |
| Rugby | 764 | 694 | — | — | 50 | 5 | 15 | 2·6 | 149 | 3·6 |
| Solihull | 635 | 537 | 1 | — | 34 | 23 | 40 | 9·9 | 161 | 5·0 |
| Southam | 272 | 228 | 1 | — | 26 | 3 | 14 | 6·7 | 61 | 3·8 |
| Stratford-on-Avon | 584 | 520 | — | — | 35 | 6 | 23 | 5·0 | 157 | 5·0 |
| Warwick | 1,387 | 1,174 | 4 | — | 145 | 14 | 50 | 4·6 | 209 | 2·9 |
| WESTMORLAND. | | | | | | | | | | |
| East Ward | 401 | 347 | — | — | 46 | 2 | 6 | 2·0 | 39 | 1·9 |
| Kendal | 1,229 | 1,130 | 4 | — | 71 | 16 | 8 | 2·0 | 79 | 1·3 |
| West Ward | 202 | 187 | — | — | 6 | 2 | 7 | 4·5 | 11 | 1·0 |
| WILTS. | | | | | | | | | | |
| Alderbury | 789 | 669 | 1 | — | 53 | 22 | 44 | 8·4 | 209 | 5·2 |
| Amesbury | 198 | 178 | — | — | 18 | 1 | 1 | 1·0 | 9 | 0·9 |
| Bradford | 308 | 281 | — | — | 21 | — | 6 | 1·9 | 24 | 1·5 |
| Calne | 211 | 180 | — | — | 14 | 13 | 4 | 8·1 | 77 | 6·7 |
| Chippenham | 665 | 597 | 1 | — | 44 | 12 | 11 | 3·5 | 109 | 3·3 |
| Cricklade and Wootton Bassett. | 344 | 296 | — | — | 37 | 1 | 10 | 3·2 | 38 | 2·1 |
| Devizes | 511 | 442 | — | — | 33 | 21 | 15 | 7·0 | 115 | 4·1 |
| Highworth and Swindon | 1,442 | 1,210 | 1 | — | 127 | 65 | 39 | 7·2 | 332 | 4·5 |
| Malmesbury | 376 | 308 | — | — | 30 | 21 | 17 | 10·1 | 88 | 4·2 |
| Marlborough | 238 | 207 | — | — | 22 | 2 | 7 | 3·8 | 28 | 2·2 |
| Melksham | 472 | 420 | 1 | — | 41 | 4 | 6 | 2·1 | 71 | 2·7 |
| Mere | 184 | 169 | — | — | 9 | 3 | 3 | 3·3 | 22 | 2·3 |
| Pewsey | 361 | 325 | 1 | — | 23 | 5 | 7 | 3·3 | 32 | 1·9 |
| Tisbury | 246 | 220 | — | — | 12 | 8 | 6 | 5·7 | 53 | 4·3 |
| Warminster | 357 | 315 | — | — | 28 | 2 | 12 | 3·9 | 86 | 5·0 |
| Westbury and Whorwellsdown. | 277 | 260 | — | — | 16 | — | 1 | 0·4 | 9 | 0·7 |
| Wilton | 255 | 235 | — | — | 18 | 2 | — | 0·8 | 26 | 1·9 |

| | Returns, 1888. | | | | | | | | Children remaining "unaccounted for" when the Returns for the several Years were received. | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Births. | Successfully Vaccinated. | Insusceptible of Vaccination. | Had Small-pox. | Died unvaccinated. | Vaccination postponed. | Remaining. | Children not finally accounted for (including cases postponed), per cent. of births. | Total Number for the Years 1883-87. | Average Per-centage for the Years 1883-87. |
| **WORCESTER.** | | | | | | | | | | |
| Bromsgrove | 1,039 | 884 | 3 | — | 109 | 25 | 18 | 4·1 | 210 | 4·0 |
| Droitwich | 525 | 465 | — | — | 47 | 3 | 10 | 2·5 | 123 | 3·4 |
| Dudley | 5,085 | 4,464 | 3 | — | 496 | 24 | 98 | 2·4 | 545 | 1·9 |
| Evesham | 456 | 415 | — | — | 23 | 2 | 16 | 3·9 | 65 | 3·0 |
| Kidderminster | 1,204 | 1,067 | 1 | — | 104 | 6 | 26 | 2·7 | 133 | 2·1 |
| King's Norton | 3,293 | 2,857 | 4 | — | 292 | 38 | 102 | 4·3 | 386 | 2·4 |
| Martley | 473 | 426 | — | — | 28 | 15 | 4 | 4·0 | 60 | 2·7 |
| Pershore | 368 | 343 | — | — | 17 | 2 | 6 | 2·2 | 25 | 1·3 |
| Shipston-on-Stour | 472 | 412 | 2 | — | 40 | 7 | 11 | 3·8 | 71 | 2·9 |
| Stourbridge | 2,841 | 2,514 | 2 | — | 282 | 15 | 28 | 1·5 | 306 | 2·0 |
| Tenbury | 208 | 188 | — | — | 10 | 3 | 7 | 4·7 | 57 | 5·7 |
| Upton-on-Severn | 497 | 446 | — | — | 34 | 6 | 11 | 3·4 | 77 | 2·8 |
| Worcester | 1,319 | 1,034 | 3 | — | 164 | 31 | 87 | 8·9 | 330 | 5·6 |
| **YORK, East Riding.** | | | | | | | | | | |
| Beverley | 747 | 629 | — | — | 68 | 18 | 32 | 6·7 | 178 | 4·8 |
| Bridlington | 443 | 373 | — | — | 41 | 3 | 26 | 6·5 | 83 | 3·5 |
| Driffield | 577 | 491 | — | — | 44 | 7 | 35 | 7·3 | 93 | 2·9 |
| Howden | 392 | 347 | 3 | — | 31 | — | 11 | 2·8 | 89 | 4·3 |
| Kingston-upon-Hull | 2,421 | 1,880 | 7 | — | 279 | 11 | 244 | 10·5 | 1,416 | 10·6 |
| Patrington | 235 | 209 | — | — | 18 | 2 | 6 | 3·4 | 23 | 1·9 |
| Pocklington | 421 | 360 | — | — | 39 | 2 | 20 | 5·2 | 84 | 3·8 |
| Sculcoates | 4,239 | 3,586 | 20 | — | 395 | 32 | 206 | 5·6 | 1,671 | 7·9 |
| Skirlaugh | 254 | 218 | — | — | 22 | 3 | 11 | 5·5 | 50 | 3·8 |
| York | 2,497 | 2,137 | 5 | — | 236 | 23 | 96 | 4·8 | 771 | 6·3 |
| **YORK, North Riding.** | | | | | | | | | | |
| Aysgarth | 134 | 115 | 1 | — | 14 | 1 | 3 | 3·0 | 22 | 3·0 |
| Bedale | 215 | 193 | — | — | 20 | — | 2 | 0·9 | 15 | 1·4 |
| Easingwold | 256 | 223 | — | — | 19 | — | 14 | 5·5 | 37 | 2·7 |
| Guisborough | 1,274 | 1,102 | 2 | — | 117 | 26 | 27 | 4·2 | 257 | 3·3 |
| Helmsley | 152 | 140 | — | — | 7 | 5 | — | 3·3 | 10 | 1·3 |
| Kirkby Moorside | 131 | 113 | 1 | — | 9 | 3 | 5 | 6·1 | 36 | 5·2 |
| Leyburn | 200 | 184 | — | — | 13 | — | 3 | 1·5 | 16 | 1·6 |
| Malton | 641 | 525 | 5 | — | 66 | 21 | 24 | 7·0 | 240 | 7·0 |
| Middlesbrough | 4,185 | 3,548 | 4 | — | 466 | 62 | 105 | 4·0 | 583 | 2·8 |
| Northallerton | 273 | 240 | — | — | 27 | 2 | 4 | 2·2 | 31 | 1·8 |
| Pickering | 325 | 282 | 2 | — | 21 | 6 | 14 | 6·2 | 81 | 4·6 |
| Reeth | 110 | 99 | — | — | 11 | — | — | 0·0 | 23 | 4·2 |
| Richmond | 366 | 311 | — | — | 27 | 11 | 17 | 7·7 | 73 | 3·9 |
| Scarborough | 1,277 | 887 | 1 | — | 148 | 87 | 154 | 19·0 | 605 | 9·3 |
| Stokesley | 307 | 280 | — | — | 24 | — | 3 | 1·0 | 33 | 2·0 |
| Thirsk | 322 | 272 | — | — | 32 | 4 | 14 | 5·6 | 84 | 4·5 |
| Whitby | 785 | 678 | — | — | 68 | 25 | 14 | 5·0 | 142 | 3·2 |
| **YORK, West Riding.** | | | | | | | | | | |
| Barnsley | 3,392 | 2,789 | 5 | — | 404 | 41 | 153 | 5·7 | 1,031 | 6·0 |
| Bierley, North | 3,711 | 3,006 | 4 | — | 418 | 68 | 215 | 7·6 | 1,085 | 5·6 |
| Bradford | 5,945 | 4,423 | 12 | — | 676 | 4 | 830 | 14·0 | 2,133 | 7·3 |
| Bramley | 1,998 | 1,659 | 4 | — | 214 | 44 | 77 | 6·1 | 439 | 4·4 |
| Dewsbury | 4,843 | 2,644 | 4 | — | 634 | 53 | 1,508 | 32·2 | 8,592 | 34·2 |
| Doncaster | 1,931 | 1,653 | 4 | — | 168 | 72 | 34 | 5·5 | 352 | 3·6 |
| Ecclesall Bierlow | 3,556 | 2,972 | 34 | — | 427 | 18 | 105 | 3·5 | 804 | 4·0 |
| Goole | 792 | 691 | 3 | — | 58 | 6 | 34 | 5·1 | 114 | 3·1 |
| Halifax | 5,040 | 2,167 | 9 | — | 607 | 82 | 2,175 | 44·8 | 3,554 | 14·0 |

| | Returns, 1888. | | | | | | | | Children remaining "unaccounted for" when the Returns for the several Years were received. | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Births. | Successfully Vaccinated. | Insusceptible of Vaccination. | Had Small-pox. | Died unvaccinated. | Vaccination postponed. | Remaining. | Children not finally accounted for (including cases postponed), per cent. of births. | Total Number for the Years 1883-87. | Average Per-centage for the Years 1883-87. |
| **YORK, West Riding—*cont.*** | | | | | | | | | | |
| Hemsworth | 502 | 417 | — | — | 54 | 4 | 27 | 6·2 | 93 | 4·1 |
| Holbeck | 835 | 699 | — | — | 98 | 21 | 17 | 4·6 | 103 | 2·4 |
| Huddersfield | 4,424 | 3,905 | 20 | — | 429 | 16 | 54 | 1·6 | 298 | 1·3 |
| Hunslet | 2,401 | 2,033 | 8 | — | 278 | 23 | 59 | 3·4 | 523 | 4·3 |
| Keighley | 1,821 | 177 | 1 | — | 210 | — | 1,433 | 78·7 | 6,438 | 71·9 |
| Knaresborough | 577 | 461 | 2 | — | 64 | 20 | 30 | 8·7 | 172 | 5·8 |
| Leeds | 6,861 | 5,798 | 26 | — | 698 | 49 | 290 | 4·9 | 733 | 2·2 |
| Ouseburn, Great | 366 | 330 | 1 | — | 28 | 1 | 6 | 1·9 | 49 | 2·7 |
| Pateley Bridge | 216 | 199 | — | — | 15 | — | 2 | 0·9 | 7 | 0·6 |
| Penistone | 543 | 476 | 2 | — | 51 | 5 | 9 | 2·6 | 88 | 3·1 |
| Pontefract | 2,116 | 1,782 | 3 | — | 229 | 12 | 90 | 4·8 | 487 | 4·8 |
| Ripon | 467 | 382 | — | — | 53 | 13 | 19 | 6·9 | 201 | 8·5 |
| Rotherham | 3,053 | 2,582 | 9 | — | 313 | 40 | 109 | 4·9 | 714 | 4·6 |
| Saddleworth | 630 | 545 | 2 | — | 43 | 2 | 38 | 6·3 | 114 | 3·4 |
| Sedbergh | 100 | 87 | — | — | 9 | 2 | 2 | 4·0 | 10 | 1·9 |
| Selby | 465 | 410 | 3 | — | 41 | 5 | 6 | 2·4 | 49 | 2·1 |
| Settle | 399 | 341 | 3 | — | 36 | 7 | 12 | 4·8 | 54 | 2·6 |
| Sheffield | 6,912 | 5,689 | 39 | 5 | 814 | 13 | 352 | 5·3 | 1,470 | 4·1 |
| Skipton | 1,220 | 964 | — | — | 130 | 40 | 86 | 10·3 | 420 | 7·3 |
| Tadcaster | 865 | 741 | 2 | — | 80 | 5 | 37 | 4·9 | 160 | 3·8 |
| Thorne | 434 | 347 | — | — | 54 | 12 | 21 | 7·6 | 158 | 7·0 |
| Wakefield | 3,392 | 2,884 | 5 | 2 | 356 | 19 | 126 | 4·3 | 589 | 3·4 |
| Wetherby | 345 | 278 | 1 | — | 40 | 7 | 19 | 7·5 | 168 | 8·6 |
| Wharfedale | 1,431 | 1,139 | 14 | — | 121 | 33 | 124 | 11·0 | 450 | 6·4 |
| Wortley | 1,191 | 999 | 4 | — | 136 | 11 | 41 | 4·4 | 263 | 3·9 |
| **ANGLESEY.** | | | | | | | | | | |
| Anglesey | 356 | 290 | — | — | 39 | 5 | 22 | 7·6 | 39 | 2·6 |
| Holyhead | 498 | 430 | — | — | 50 | 4 | 14 | 3·6 | 90 | 3·3 |
| **BRECKNOCK.** | | | | | | | | | | |
| Brecknock | 416 | 360 | — | — | 38 | 3 | 15 | 4·3 | 43 | 2·0 |
| Builth | 234 | 202 | — | — | 24 | 3 | 5 | 3·4 | 26 | 2·2 |
| Crickhowell | 612 | 527 | — | — | 55 | 7 | 23 | 4·9 | 101 | 3·0 |
| Hay | 299 | 257 | — | — | 36 | 1 | 5 | 2·0 | 61 | 4·2 |
| **CARDIGAN.** | | | | | | | | | | |
| Aberayron | 311 | 274 | — | — | 24 | 2 | 11 | 4·2 | 54 | 3·4 |
| Aberystwith | 502 | 451 | — | — | 37 | 4 | 10 | 2·8 | 95 | 3·6 |
| Cardigan | 423 | 382 | — | — | 29 | 6 | 6 | 2·8 | 56 | 2·5 |
| Lampeter | 262 | 233 | — | — | 24 | 4 | 1 | 1·9 | 57 | 4·2 |
| Tregaron | 239 | 215 | — | — | 17 | 1 | 6 | 2·9 | 23 | 1·9 |
| **CARMARTHEN.** | | | | | | | | | | |
| Carmarthen | 987 | 895 | — | — | 86 | 1 | 5 | 0·6 | 61 | 1·2 |
| Llanelly | 1,713 | 1,545 | — | — | 131 | 22 | 15 | 2·2 | 218 | 2·6 |
| Llandilofawr | 581 | 517 | — | — | 54 | 2 | 8 | 1·7 | 53 | 1·8 |
| Llandovery | 300 | 269 | — | — | 28 | 2 | 1 | 1·0 | 41 | 2·5 |
| Newcastle-in-Emlyn | 502 | 455 | — | — | 40 | 3 | 4 | 1·4 | 26 | 1·0 |

| | Returns, 1888. | | | | | | | | Children remaining "unaccounted for" when the Returns for the several Years were received. | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Births. | Successfully Vaccinated. | Insusceptible of Vaccination. | Had Small-pox. | Died unvaccinated. | Vaccination postponed. | Remaining. | Children not finally accounted for (including cases postponed), per cent. of births. | Total Number for the Years 1883-87. | Average Per-centage for the Years 1883-87. |
| **CARNARVON.** | | | | | | | | | | |
| Bangor and Beaumaris | 954 | 850 | 1 | — | 87 | 6 | 10 | 1·7 | 116 | 2·2 |
| Carnarvon | 1,192 | 1,025 | 1 | — | 131 | 17 | 18 | 2·9 | 161 | 2·7 |
| Conway | 586 | 512 | 1 | — | 58 | 3 | 12 | 2·6 | 83 | 3·1 |
| Pwllheli | 586 | 513 | — | — | 48 | 8 | 17 | 4·3 | 117 | 3·9 |
| **DENBIGH.** | | | | | | | | | | |
| Llanrwst | 317 | 281 | — | — | 28 | 2 | 6 | 2·5 | 82 | 4·5 |
| Ruthin | 345 | 307 | — | — | 33 | 2 | 3 | 1·4 | 22 | 1·3 |
| Wrexham | 1,880 | 1,621 | 1 | — | 190 | 25 | 43 | 3·6 | 313 | 3·3 |
| **FLINT.** | | | | | | | | | | |
| Asaph, St. | 690 | 622 | 1 | — | 50 | 2 | 15 | 2·5 | 126 | 3·4 |
| Hawarden | 426 | 385 | — | — | 25 | 4 | 12 | 3·8 | 94 | 3·9 |
| Holywell | 1,201 | 1,031 | 1 | — | 103 | 18 | 48 | 5·5 | 237 | 3·7 |
| **GLAMORGAN.** | | | | | | | | | | |
| Bridgend and Cowbridge | 1,511 | 1,318 | 3 | — | 124 | 34 | 32 | 4·4 | 234 | 3·3 |
| Cardiff | 5,745 | 4,789 | 12 | — | 531 | 21 | 392 | 7·2 | 1,534 | 6·0 |
| Gower | 278 | 254 | — | — | 17 | 3 | 4 | 2·5 | 57 | 3·6 |
| Merthyr Tydfil | 3,835 | 3,439 | 4 | — | 314 | 38 | 40 | 2·0 | 393 | 2·1 |
| Neath | 1,873 | 1,696 | 1 | — | 137 | 6 | 34 | 2·1 | 202 | 2·1 |
| Pontardawe | 731 | 649 | — | — | 64 | 11 | 7 | 2·5 | 60 | 1·7 |
| Pontypridd | 4,909 | 4,123 | 7 | — | 537 | 59 | 183 | 4·9 | 957 | 4·2 |
| Swansea | 3,790 | 3,376 | 1 | — | 293 | 21 | 99 | 3·2 | 395 | 2·1 |
| **MERIONETH.** | | | | | | | | | | |
| Bala | 163 | 134 | 1 | — | 19 | 7 | 2 | 5·5 | 23 | 2·7 |
| Corwen | 436 | 376 | 1 | — | 42 | 10 | 7 | 3·9 | 113 | 5·1 |
| Dolgelley | 379 | 338 | — | — | 31 | 5 | 5 | 2·6 | 49 | 2·5 |
| Festiniog | 800 | 703 | — | — | 75 | 16 | 6 | 2·7 | 139 | 3·1 |
| **MONTGOMERY.** | | | | | | | | | | |
| Llanfyllin | 567 | 501 | — | — | 50 | 6 | 10 | 2·8 | 88 | 3·0 |
| Machynlleth | 301 | 267 | 1 | — | 27 | 3 | 3 | 2·0 | 37 | 2·6 |
| Forden | 410 | 360 | — | — | 34 | 4 | 12 | 3·9 | 90 | 3·7 |
| Newtown and Llanidloes | 632 | 568 | — | — | 41 | 7 | 16 | 3·6 | 148 | 4·5 |
| **PEMBROKE.** | | | | | | | | | | |
| Haverfordwest | 931 | 745 | — | — | 92 | 41 | 53 | 10·1 | 250 | 5·1 |
| Narberth | 528 | 463 | — | — | 38 | 14 | 13 | 5·1 | 147 | 5·3 |
| Pembroke | 954 | 829 | 1 | — | 69 | 33 | 22 | 5·8 | 232 | 4·6 |
| **RADNOR.** | | | | | | | | | | |
| Knighton | 324 | 252 | — | — | 41 | 13 | 18 | 9·6 | 101 | 6·0 |
| Rhayader | 180 | 156 | — | — | 15 | — | 9 | 5·0 | 27 | 3·1 |

## No. 2.

List (alphabetically arranged) of 284 Unions inspected during the Year 1890, with reference to the Proceedings under the Vaccination Acts, 1867 and 1871, and an Account of the Awards certified by the Board as payable to the respective Public Vaccinators out of County Funds.

| Union. | No. of Vaccination Districts in the Union. | No. of Public Vaccinators recommended for Award. | Range of Awards in each Union. Minimum. | Range of Awards in each Union. Maximum. | Total Sum awarded in each Union. | Medical Inspector. |
|---|---|---|---|---|---|---|
| | | | £ s. d. | £ s. d. | £ s. d. | |
| Abergavenny | 3 | 2 | 5 17 0 | 25 13 0 | 31 10 0 | Mr. Spear. |
| Alderbury | 5 | 3 | 3 3 0 | 25 17 0 | 37 6 0 | Dr. Blaxall. |
| Alresford | 2 | 1 | — | — | 6 15 0 | Mr. Sweeting. |
| Alton | 4 | 3 | 4 10 0 | 8 10 0 | 18 13 0 | Do. |
| Altrincham | 6 | 5 | 6 8 0 | 46 6 0 | 90 4 0 | Dr. Page. |
| Alverstoke | 1 | 1 | — | — | 52 7 0 | Mr. Sweeting. |
| Amersham | 6 | 2 | 7 17 0 | 23 7 0 | 31 4 0 | Dr. Parsons. |
| Amesbury | 2 | 2 | 4 16 0 | 9 10 0 | 14 6 0 | „ Blaxall. |
| Ampthill | 4 | 3 | 5 3 0 | 7 13 0 | 19 12 0 | „ BruceLow. |
| Andover | 5 | 3 | 1 3 0 | 13 6 0 | 19 5 0 | Mr. Sweeting. |
| Ashby-de-la-Zouch | 6 | 4 | 7 9 0 | 22 8 0 | 52 15 0 | Dr. Parsons. |
| Ashton-under-Lyne | 9 | 7 | 3 5 0 | 44 10 0 | 153 4 0 | Mr. Thompson. |
| Atcham | 7 | 5 | 3 16 0 | 28 19 0 | 54 10 0 | Dr. Parsons. |
| Austell, St. | 7 | 1 | — | — | 21 7 0 | „ Ballard. |
| Aylesbury | 7 | 5 | 3 16 0 | 20 10 0 | 45 11 0 | „ Bruce Low. |
| Aylsham | 7 | 1 | — | — | 8 7 0 | Mr. Thompson. |
| Banbury | 7 | 3 | 4 5 0 | 7 13 0 | 16 7 0 | Dr. Blaxall. |
| Barrow-on-Soar | 6 | 2 | 5 13 0 | 6 2 0 | 11 15 0 | „ Parsons. |
| Barton-upon-Irwell | 6 | 5 | 3 12 0 | 36 13 0 | 100 1 0 | Mr. Thompson. |
| Basingstoke | 7 | 4 | 0 12 0 | 4 3 0 | 10 0 0 | „ Sweeting. |
| Beaminster | 5 | 3 | 2 5 0 | 6 1 0 | 11 18 0 | Dr. Blaxall. |
| Bedford | 8 | 7 | 3 16 0 | 23 16 0 | 51 9 0 | „ BruceLow. |
| Bedwellty | 6 | 5 | 2 16 0 | 41 7 0 | 125 6 0 | Mr. Spear. |
| Bicester | 7 | 3 | 0 19 0 | 5 19 0 | 8 17 0 | Dr. Blaxall. |
| Biggleswade | 5 | 3 | 6 15 0 | 11 16 0 | 28 2 0 | „ BruceLow. |
| Billesdon | 3 | 1 | — | — | 9 8 0 | „ Parsons. |
| Birkenhead | 3 | 1 | — | — | 118 4 0 | Mr. Sweeting. |

App. A. No. 2.

Inspection of Public Vaccination.

| UNION. | No. of Vaccination Districts in the Union. | No. of Public Vaccinators recommended for Award. | Range of Awards in each Union. Minimum. £ s. d. | Range of Awards in each Union. Maximum. £ s. d. | Total Sum awarded in each Union. £ s. d. | Medical Inspector. |
|---|---|---|---|---|---|---|
| Birmingham | 1 | 1 | — | — | 189 17 0 | Dr. Airy. |
| Blaby | 3 | — | — | — | — | „ Parsons. |
| Blandford | 4 | 3 | 2 12 0 | 9 5 0 | 16 17 0 | „ Blaxall. |
| Blofield | 3 | 3 | 4 10 0 | 25 15 0 | 46 3 0 | Mr. Thompson. |
| Bodmin | 7 | 4 | 3 2 0 | 6 10 0 | 19 5 0 | Dr. Ballard. |
| Boston | 8 | 5 | 3 11 0 | 20 16 0 | 54 11 0 | „ BruceLow. |
| Bourn | 7 | 2 | 4 6 0 | 5 0 0 | 9 6 0 | Do. |
| Bradford (Wilts) | 3 | 1 | — | — | 4 16 0 | „ Blaxall. |
| Braintree | 7 | 6 | 8 2 0 | 22 1 0 | 79 18 0 | „ Airy. |
| Brentford | 9 | 4 | 9 18 0 | 22 3 0 | 64 14 0 | „ BruceLow. |
| Bridgend and Cowbridge | 6 | 2 | 11 2 0 | 28 9 0 | 39 11 0 | Mr. Spear. |
| Bridgnorth | 3 | 2 | 2 16 0 | 6 16 0 | 9 12 0 | Dr. Parsons. |
| Bridport | 3 | 2 | 4 6 0 | 19 4 0 | 23 10 0 | „ Blaxall. |
| Bromsgrove | 5 | 5 | 0 12 0 | 20 15 0 | 47 4 0 | Mr. Spear. |
| Bromyard | 3 | 3 | 4 2 0 | 10 6 0 | 20 11 0 | Do. |
| Buckingham | 3 | 2 | 6 5 0 | 11 15 0 | 18 0 0 | Dr. BruceLow |
| Burton-on-Trent | 8 | 6 | 4 16 0 | 47 12 0 | 109 19 0 | „ Parsons. |
| Caistor | 10 | 3 | 0 19 0 | 4 1 0 | 8 14 0 | Dr. BruceLow. |
| Camberwell | 5 | 4 | 2 7 0 | 92 14 0 | 220 10 0 | „ Airy. |
| Cambridge | 1 | 1 | — | — | 47 15 0 | Do. |
| Camelford | 2 | — | — | — | — | „ Ballard. |
| Cannock | 6 | 2 | 6 6 0 | 27 8 0 | 33 14 0 | „ Parsons. |
| Catherington | 1 | — | — | — | — | Mr. Sweeting. |
| Caxton and Arrington | 4 | 3 | 6 5 0 | 7 13 0 | 20 17 0 | Dr. Airy. |
| Cerne | 4 | 1 | — | — | 0 18 0 | „ Blaxall. |
| Cheadle | 5 | 5 | 5 12 0 | 12 16 0 | 38 11 0 | „ Parsons. |
| Chelmsford | 9 | 8 | 4 1 0 | 15 0 0 | 70 2 0 | „ Airy. |
| Chepstow | 5 | 3 | 6 11 0 | 12 9 0 | 26 15 0 | Mr. Spear. |
| Chesterton | 7 | 3 | 6 15 0 | 8 3 0 | 22 12 0 | Dr. Airy. |
| Chippenham | 6 | 3 | 2 19 0 | 13 14 0 | 30 3 0 | „ Blaxall. |
| Chipping Norton | 4 | 3 | 4 12 0 | 12 14 0 | 27 10 0 | Do. |
| Chorlton | 13 | 9 | 2 15 0 | 94 16 0 | 422 4 0 | Mr. Thompson. |
| Christchurch | 3 | 1 | — | — | 7 5 0 | „ Sweeting. |
| Church Stretton | 4 | 2 | 1 17 0 | 4 5 0 | 6 2 0 | Dr. Parsons. |
| Cleobury Mortimer | 2 | 1 | — | — | 6 18 0 | Do. |
| Clun | 4 | 1 | — | — | 3 8 0 | Do. |

| UNION. | No. of Vaccination Districts in the Union. | No. of Public Vaccinators recommended for Award. | Range of Awards in each Union. | | Total Sum awarded in each Union. | Inspector. |
|---|---|---|---|---|---|---|
| | | | Minimum. | Maximum. | | |
| | | | £ s. d. | £ s. d. | £ s. d. | |
| Clutton - - - | 5 | 4 | 1 4 0 | 28 3 0 | 51 3 0 | Dr. Blaxall. |
| Columb, St., Major - | 6 | 4 | 2 15 0 | 6 8 0 | 19 19 0 | „ Ballard. |
| Congleton - - | 4 | 3 | 10 12 0 | 51 12 0 | 110 17 0 | Mr. Sweeting. |
| Coventry - - - | 1 | 1 | — | — | 80 8 0 | Dr. Airy. |
| Cricklade and Wootton Bassett. | 3 | — | — | — | — | „ Blaxall. |
| Darlington - - | 5 | 5 | 2 17 0 | 40 3 0 | 56 1 0 | Mr. Thompson. |
| Depwade - - - | 8 | 6 | 2 13 0 | 18 0 0 | 70 8 0 | Do. |
| Devizes - - - | 6 | 3 | 1 4 0 | 4 9 0 | 9 14 0 | Dr. Blaxall. |
| Docking - - - | 4 | 3 | 6 7 0 | 11 7 0 | 25 11 0 | Mr. Thompson. |
| Dorchester - - | 6 | 2 | 1 0 0 | 3 12 0 | 4 12 0 | Dr. Blaxall. |
| Dore - - - | 3 | 2 | 4 11 0 | 5 9 0 | 10 0 0 | Mr. Spear. |
| Downham - - | 7 | 3 | 8 17 0 | 14 14 0 | 34 4 0 | „ Thompson. |
| Drayton - - - | 5 | 2 | 1 15 0 | 2 14 0 | 4 9 0 | Dr. Parsons. |
| Droitwich - - | 6 | 5 | 4 13 0 | 12 6 0 | 36 19 0 | Mr. Spear. |
| Droxford - - - | 4 | 2 | 4 7 0 | 6 16 0 | 11 3 0 | „ Sweeting. |
| Dudley - - - | 8 | 8 | 16 6 0 | 41 19 0 | 213 2 0 | „ Spear. |
| Dunmow - - - | 6 | 4 | 6 2 0 | 11 4 0 | 36 12 0 | Dr. Airy. |
| Ecclesall Bierlow - | 3 | 2 | 91 12 0 | 117 3 0 | 208 15 0 | Dr. Barry. |
| Edmonton - - | 13 | 9 | 0 18 0 | 36 11 0 | 119 5 0 | „ BruceLow. |
| Ellesmere - - - | 6 | 3 | 3 16 0 | 7 3 0 | 15 14 0 | „ Parsons. |
| Ely - - - | 5 | 2 | 4 14 0 | 12 15 0 | 17 9 0 | „ Airy. |
| Erpingham - - | 3 | 1 | — | — | 24 5 0 | Mr. Thompson. |
| Eton - - - | 8 | 4 | 4 1 0 | 14 2 0 | 28 10 0 | Dr. BruceLow. |
| Evesham - - - | 5 | 5 | 1 7 0 | 16 0 0 | 32 19 0 | Mr. Spear. |
| Faith, St. - - - | 5 | 4 | 3 2 0 | 6 5 0 | 19 3 0 | Mr. Thompson. |
| Falmouth - - - | 4 | 2 | 2 7 0 | 10 5 0 | 12 12 0 | Dr. Ballard. |
| Fareham - - - | 5 | 1 | — | — | 5 4 0 | Mr. Sweeting. |
| Flegg, East and West - | 4 | — | — | — | — | „ Thompson. |
| Fordingbridge - - | 2 | 2 | 3 19 0 | 7 1 0 | 11 0 0 | „ Sweeting. |
| Forehoe - - - | 6 | 4 | 5 7 0 | 23 1 0 | 43 13 0 | „ Thompson. |
| Freebridge Lynn - | 4 | 4 | 8 8 0 | 17 0 0 | 47 4 0 | Do. |
| Frome - - - | 5 | 1 | — | — | 4 4 0 | Dr. Blaxall. |
| Fulham - - - | 3 | 3 | 70 2 0 | 90 4 0 | 241 16 0 | „ Airy. |

App. A. No. 2.

Inspection of Public Vaccination.

| UNION. | No. of Vaccination Districts in the Union. | No. of Public Vaccinators recommended for Award. | Range of Awards in each Union. Minimum. £ s. d. | Range of Awards in each Union. Maximum. £ s. d. | Total Sum awarded in each Union. £ s. d. | Medical Inspector. |
|---|---|---|---|---|---|---|
| Gainsborough - - | 8 | 5 | 3 12 0 | 35 16 0 | 57 6 0 | Dr. BruceLow. |
| George's, St. - - | 4 | 4 | 4 0 0 | 58 12 0 | 94 6 0 | „ Airy. |
| German's, St. - - | 6 | 4 | 3 0 0 | 8 6 0 | 24 18 0 | „ Ballard. |
| Giles, St., and St. Geo. Bloomsbury. | 1 | 1 | — | — | 27 4 0 | „ Airy. |
| Glanford Brigg - - | 9 | 5 | 5 15 0 | 11 19 0 | 46 14 0 | „ BruceLow. |
| Grantham - - | 7 | 7 | 2 13 0 | 29 8 0 | 62 17 0 | Do. |
| Greenwich - - | 2 | 2 | 40 18 0 | 54 17 0 | 95 15 0 | „ Airy. |
| Guiltcross - - | 5 | 4 | 5 6 0 | 13 9 0 | 38 13 0 | Mr. Thompson. |
| Guisborough - - | 7 | 2 | 12 3 0 | 18 4 0 | 30 7 0 | „ Sweeting. |
| Hartley Wintney - | 6 | 4 | 1 19 0 | 9 17 0 | 27 18 0 | Mr. Sweeting. |
| Havant - - | 4 | 3 | 1 8 0 | 5 8 0 | 10 17 0 | Do. |
| Headington - - | 2 | 1 | — | — | 62 0 0 | Dr. Blaxall. |
| Helston - - - | 5 | 3 | 9 3 0 | 12 11 0 | 32 8 0 | „ Ballard. |
| Hemsworth - - | 4 | 3 | 1 11 0 | 10 17 0 | 15 19 0 | Mr. Sweeting. |
| Hendon - - - | 7 | 5 | 2 16 0 | 45 19 0 | 84 19 0 | Dr. BruceLow. |
| Henley - - - | 6 | 2 | 6 19 0 | 11 10 0 | 18 9 0 | „ Blaxall. |
| Henstead - - - | 4 | 1 | — | — | 11 4 0 | Mr. Thompson. |
| Hereford - - - | 4 | 4 | 4 19 0 | 19 9 0 | 40 9 0 | „ Spear. |
| Hinckley - - | 5 | 3 | 6 17 0 | 23 13 0 | 46 18 0 | Dr. Parsons. |
| Holbeach - - - | 6 | 4 | 4 13 0 | 10 2 0 | 31 6 0 | „ BruceLow. |
| Holborn - - - | 4 | 3 | 32 8 0 | 48 17 0 | 117 6 0 | „ Airy. |
| Horncastle - - | 6 | 4 | 6 18 0 | 12 11 0 | 34 19 0 | „ BruceLow. |
| Hunslet - - - | 4 | 4 | 3 2 0 | 78 2 0 | 105 1 0 | „ Barry. |
| Huntingdon - - | 5 | 3 | 5 11 0 | 11 6 0 | 22 15 0 | „ Airy. |
| Hursley - - - | 1 | 1 | — | — | 6 1 0 | Mr. Sweeting. |
| Ives, St. - - - | 5 | 4 | 4 14 0 | 9 4 0 | 28 12 0 | Dr. Airy. |
| Kensington - - | 2 | 2 | 36 0 0 | 106 18 0 | 142 18 0 | Dr. Airy. |
| Kidderminster - - | 5 | 3 | 5 6 0 | 10 4 0 | 22 8 0 | Mr. Spear. |
| Kingsclere - - | 3 | 2 | 5 19 0 | 9 18 0 | 15 17 0 | „ Sweeting |
| King's Lynn - - | 1 | 1 | — | — | 56 5 0 | „ Thompson. |
| King's Norton - - | 7 | 6 | 0 18 0 | 64 13 0 | 138 13 0 | „ Spear. |
| Kingston-on-Hull - | 2 | 2 | 22 11 0 | 56 3 0 | 78 14 0 | Dr. Barry. |
| Kington - - - | 5 | 4 | 1 11 0 | 9 1 0 | 20 3 0 | Mr. Spear. |

| UNION. | No. of Vaccination Districts in the Union. | No. of Public Vaccinators recommended for Award. | Range of Awards in each Union. Minimum. | Range of Awards in each Union. Maximum. | Total Sum awarded in each Union. | Medical Inspector. |
|---|---|---|---|---|---|---|
| | | | £ s. d. | £ s. d. | £ s. d. | |
| Launceston - - | 8 | 4 | 4 12 0 | 5 17 0 | 21 9 0 | Dr. Ballard. |
| Ledbury - - - | 3 | 2 | 7 8 0 | 8 6 0 | 15 14 0 | Mr. Spear. |
| Leeds - - - | 7 | 7 | 1 3 0 | 42 16 0 | 128 15 0 | Dr. Airy. |
| Leek - - - | 5 | 5 | 1 16 0 | 24 0 0 | 48 17 0 | „ Parsons. |
| Leicester - - - | 2 | 1 | — | — | 2 3 0 | Do. |
| Leighton Buzzard - | 2 | 2 | 1 13 0 | 27 19 0 | 29 12 0 | „ BruceLow. |
| Leominster - - | 3 | 2 | 7 3 0 | 15 4 0 | 22 7 0 | Mr. Spear. |
| Lexden and Winstree - | 10 | 8 | 4 7 0 | 15 19 0 | 61 0 0 | Dr. Airy. |
| Lichfield - - - | 6 | 3 | 3 13 0 | 22 16 0 | 47 5 0 | „ Parsons. |
| Lincoln - - - | 11 | 6 | 2 19 0 | 38 6 0 | 61 16 0 | „ BruceLow. |
| Linton - - - | 3 | 2 | 7 16 0 | 11 19 0 | 19 15 0 | „ Airy. |
| Liskeard - - - | 7 | 4 | 3 10 0 | 9 12 0 | 22 7 0 | „ Ballard. |
| Liverpool - - - | 3 | 5 | 3 13 0 | 94 18 0 | 193 11 0 | „ Airy. |
| Loddon and Clavering - | 4 | 2 | 13 14 0 | 14 7 0 | 28 1 0 | Mr. Thompson. |
| Loughborough - - | 4 | 2 | 11 7 0 | 14 14 0 | 26 1 0 | Dr. Parsons. |
| Louth - - - | 11 | 9 | 1 13 0 | 13 16 0 | 54 15 0 | „ BruceLow. |
| Ludlow - - - | 5 | 1 | — | — | 3 14 0 | „ Parsons. |
| Luton - - - | 6 | 5 | 3 8 0 | 7 2 0 | 24 3 0 | „ BruceLow. |
| Lutterworth - - | 6 | 3 | 3 16 0 | 8 0 0 | 16 4 0 | „ Parsons. |
| Lymington - - | 4 | 2 | 3 3 0 | 3 17 0 | 7 0 0 | Mr. Sweeting. |
| Macclesfield - - | 6 | 4 | 1 3 0 | 63 9 0 | 96 19 0 | Mr. Sweeting. |
| Madeley - - - | 4 | 2 | 7 3 0 | 18 0 0 | 25 3 0 | Dr. Parsons. |
| Maldon - - - | 8 | 6 | 2 13 0 | 16 2 0 | 44 6 0 | „ Airy |
| Market Bosworth - | 6 | 3 | 1 3 0 | 10 0 0 | 20 9 0 | „ Parsons. |
| Market Harborough - | 5 | 1 | — | — | 5 6 0 | Do. |
| Marlborough - - | 2 | 2 | 2 17 0 | 11 14 0 | 14 11 0 | „ Blaxall. |
| Martley - - - | 6 | 4 | 3 0 0 | 9 2 0 | 23 6 0 | Mr. Spear. |
| Melksham - - - | 2 | 2 | 9 3 0 | 20 1 0 | 29 4 0 | Dr. Blaxall. |
| Melton Mowbray - | 7 | 4 | 2 19 0 | 7 6 0 | 20 19 0 | „ Parsons. |
| Mere - - - | 2 | 2 | 5 9 0 | 8 19 0 | 14 8 0 | „ Blaxall. |
| Middlesbrough - - | 4 | 4 | 42 1 0 | 128 10 0 | 390 14 0 | Mr. Sweeting. |
| Mitford and Launditch - | 9 | 4 | 1 12 0 | 16 3 0 | 35 15 0 | „ Thompson. |
| Monmouth - - | 6 | 4 | 2 16 0 | 24 17 0 | 50 19 0 | „ Spear. |

App. A. No. 2.

Inspection of Public Vaccination.

| UNION. | No. of Vaccination Districts in the Union. | No. of Public Vaccinators recommended for Award. | Range of Awards in each Union. Minimum. | Range of Awards in each Union. Maximum. | Total Sum awarded in each Union. | Medical Inspector. |
|---|---|---|---|---|---|---|
| | | | £ s. d. | £ s. d. | £ s. d. | |
| Nantwich - - - | 8 | 4 | 7 4 0 | 64 18 0 | 113 12 0 | Mr. Sweeting. |
| Neot's, St. - - - | 6 | 5 | 0 13 0 | 14 3 0 | 25 9 0 | Dr. Airy. |
| Newcastle-under-Lyme - | 3 | 1 | — | — | 36 14 0 | „ Parsons. |
| Newcastle-on-Tyne - | 3 | 4 | 25 6 0 | 68 13 0 | 166 18 0 | „ Airy. |
| New Forest - - | 5 | 2 | 4 19 0 | 13 17 0 | 18 16 0 | Mr. Sweeting. |
| Newmarket - - | 8 | 6 | 3 0 0 | 16 17 0 | 52 14 0 | Dr. Airy. |
| Newport (Mon.) - - | 9 | 5 | 9 12 0 | 74 17 0 | 166 5 0 | Mr. Spear. |
| Newport (Salop) - - | 4 | 2 | 7 17 0 | 8 8 0 | 16 5 0 | Dr. Parsons. |
| Newport Pagnell - | 10 | 4 | 1 7 0 | 16 12 0 | 27 5 0 | „ BruceLow. |
| North Bierley - - | 13 | 5 | 6 7 0 | 23 1 0 | 73 5 0 | „ Barry. |
| Northwich - - | 5 | 4 | 35 14 0 | 60 3 0 | 173 16 0 | Mr. Sweeting. |
| North Witchford - | 4 | 4 | 3 9 0 | 9 15 0 | 27 16 0 | Dr. Airy. |
| Norwich - - - | 1 | 1 | — | — | 193 11 0 | Mr. Thompson. |
| Olave, St. - - - | 3 | 3 | 37 18 0 | 70 16 0 | 167 3 0 | Dr. Airy. |
| Ongar - - - | 4 | 5 | 1 6 0 | 8 11 0 | 27 10 0 | Do. |
| Ormskirk - - - | 6 | 6 | 9 6 0 | 56 16 0 | 170 9 0 | Mr. Thompson. |
| Orsett - - - | 5 | 4 | 5 16 0 | 34 8 0 | 64 18 0 | Dr. Airy. |
| Oswestry - - - | 5 | 3 | 4 5 0 | 27 14 0 | 46 15 0 | „ Parsons. |
| Oxford - - - | 1 | 1 | — | — | 31 17 0 | „ Blaxall. |
| Paddington - - | 1 | 1 | — | — | 55 3 0 | Dr. Airy. |
| Penistone - - - | 3 | 3 | 10 2 0 | 29 5 0 | 52 15 0 | „ Barry. |
| Penzance - - - | 5 | 3 | 12 3 0 | 20 16 0 | 50 4 0 | „ Ballard. |
| Pershore - - - | 5 | 2 | 4 19 0 | 8 3 0 | 13 2 0 | Mr. Spear. |
| Petersfield - - - | 4 | 2 | 3 13 0 | 6 3 0 | 9 16 0 | „ Sweeting. |
| Pewsey - - - | 5 | 2 | 5 17 0 | 7 7 0 | 13 4 0 | Dr. Blaxall. |
| Pontefract - - | 7 | 6 | 2 15 0 | 41 7 0 | 103 16 0 | Mr. Sweeting. |
| Pontypool - - - | 4 | 1 | — | — | 32 18 0 | „ Spear. |
| Poole - - - | 4 | 3 | 4 3 0 | 11 5 0 | 23 7 0 | Dr. Blaxall. |
| Poplar - - - | 4 | 4 | 34 10 0 | 116 16 0 | 250 11 0 | „ Airy. |
| Portsea Island - - | 1 | 1 | — | — | 140 2 0 | Mr. Sweeting. |
| Prestcot - - - | 6 | 3 | 17 14 0 | 77 7 0 | 145 3 0 | „ Thompson. |
| Prestwich - - - | 6 | 3 | 42 6 0 | 126 0 0 | 226 14 0 | Do. |

| UNION. | No. of Vaccination Districts in the Union. | No. of Public Vaccinators recommended for Award. | Range of Awards in each Union. Minimum. | Range of Awards in each Union. Maximum. | Total Sum awarded in each Union. | Medical Inspector. |
|---|---|---|---|---|---|---|
| | | | £ s. d. | £ s. d. | £ s. d. | |
| Redruth | 6 | 2 | 18 19 0 | 19 15 0 | 38 14 0 | Dr. Ballard. |
| Ringwood | 1 | 1 | — | — | 12 4 0 | Mr. Sweeting. |
| Rochford | 5 | 5 | 8 15 0 | 26 4 0 | 83 14 0 | Dr. Airy. |
| Romsey | 5 | 1 | — | — | 14 0 0 | Mr. Sweeting. |
| Ross | 4 | 1 | — | — | 17 19 0 | „ Spear. |
| Runcorn | 4 | 2 | 21 16 0 | 49 14 0 | 71 10 0 | „ Sweeting. |
| Saddleworth | 1 | 1 | — | — | 38 11 0 | Dr. Barry. |
| Saffron Walden | 6 | 5 | 2 11 0 | 25 8 0 | 54 11 0 | „ Airy. |
| Sedbergh | 2 | 2 | 2 19 0 | 5 0 0 | 7 19 0 | Do. |
| Seisdon | 4 | 4 | 4 9 0 | 8 9 0 | 22 9 0 | „ Parsons. |
| Shaftesbury | 3 | 2 | 3 2 0 | 9 3 0 | 12 5 0 | „ Blaxall. |
| Sheffield | 6 | 4 | 23 15 0 | 44 10 0 | 129 16 0 | „ Airy. |
| Shepton Mallet | 5 | — | — | — | — | „ Blaxall. |
| Sherborne | 3 | 2 | 5 3 0 | 5 10 0 | 10 13 0 | Do. |
| Shifnal | 4 | 2 | 5 5 0 | 8 4 0 | 13 9 0 | „ Parsons. |
| Shipston-on-Stour | 5 | 5 | 3 10 0 | 11 16 0 | 34 11 0 | Mr. Spear. |
| Shoreditch | 3 | 3 | 34 19 0 | 116 15 0 | 222 7 0 | Dr. Airy. |
| Sleaford | 7 | 2 | 4 8 0 | 8 9 0 | 12 17 0 | „ BruceLow. |
| Smallburgh | 4 | 4 | 13 15 0 | 20 6 0 | 67 0 0 | Mr. Thompson. |
| Southampton | 2 | 2 | 49 7 0 | 57 7 0 | 106 14 0 | „ Sweeting. |
| South Stoneham | 5 | 5 | 8 4 0 | 25 15 0 | 86 17 0 | Do. |
| Spalding | 9 | 3 | 7 1 0 | 15 11 0 | 33 7 0 | Dr. BruceLow. |
| Spilsby | 7 | 5 | 5 2 0 | 9 6 0 | 36 11 0 | Do. |
| Stafford | 4 | 4 | 4 1 0 | 19 5 0 | 48 3 0 | „ Parsons. |
| Staines | 7 | 4 | 3 9 0 | 11 1 0 | 30 4 0 | „ BruceLow. |
| Stamford | 7 | 4 | 2 18 0 | 20 17 0 | 33 5 0 | Do. |
| Stepney | 1 | — | — | — | — | „ Airy. |
| Stockbridge | 2 | 2 | 6 9 0 | 7 3 0 | 13 12 0 | Mr. Sweeting. |
| Stockport | 5 | 5 | 4 18 0 | 51 19 0 | 164 12 0 | Do. |
| Stokesley | 4 | 1 | — | — | 3 8 0 | Do. |
| Stoke-upon-Trent | 5 | 5 | 8 13 0 | 81 7 0 | 194 17 0 | Dr. Parsons. |
| Stone | 4 | 3 | 9 15 0 | 21 8 0 | 42 10 0 | Do. |
| Stourbridge | 7 | 5 | 6 8 0 | 23 12 0 | 82 8 0 | Mr. Spear. |
| Strand | 1 | 1 | — | — | 9 6 0 | Dr. Airy. |
| Stratton | 2 | 1 | — | — | 12 2 0 | „ Ballard. |
| Sturminster | 4 | 3 | 3 1 0 | 7 11 0 | 15 1 0 | „ Blaxall. |
| Swaffham | 6 | 5 | 0 12 0 | 13 4 0 | 29 0 0 | Mr. Thompson. |

App. A. No. 2.

Inspection of Public Vaccination.

| UNION. | No. of Vaccination Districts in the Union. | No. of Public Vaccinators recommended for Award. | Range of Awards in each Union. Minimum. £ s. d. | Range of Awards in each Union. Maximum. £ s. d. | Total Sum awarded in each Union. £ s. d. | Medical Inspector. |
|---|---|---|---|---|---|---|
| Tamworth - - - | 3 | 2 | 19 12 0 | 21 10 0 | 41 2 0 | Dr. Parsons. |
| Tarvin - - - | 2 | 2 | 13 1 0 | 18 2 0 | 31 3 0 | Mr. Sweeting. |
| Taunton - - - | 7 | 6 | 4 2 0 | 27 10 0 | 74 18 0 | Dr. Blaxall. |
| Tenbury - - - | 2 | 1 | — | — | 6 11 0 | Mr. Spear. |
| Thame - - - | 6 | 4 | 0 8 0 | 8 13 0 | 21 3 0 | Dr. Blaxall. |
| Thetford - - - | 6 | 3 | 7 14 0 | 13 1 0 | 29 9 0 | Mr. Thompson. |
| Tisbury - - - | 3 | 3 | 4 7 0 | 6 14 0 | 17 10 0 | Dr. Blaxall. |
| Toxteth Park - - | 2 | 2 | 50 15 0 | 70 0 0 | 120 15 0 | „ Airy. |
| Truro - - - | 7 | 2 | 3 17 0 | 13 4 0 | 17 1 0 | „ Ballard. |
| Upton-on-Severn - - | 6 | 5 | 0 15 0 | 14 7 0 | 36 14 0 | Mr. Spear. |
| Uttoxeter - - - | 5 | — | — | — | — | Dr. Parsons. |
| Uxbridge - - - | 7 | 5 | 2 8 0 | 15 11 0 | 45 9 0 | „ Bruce Low. |
| Walsall - - - | 4 | 4 | 14 10 0 | 43 19 0 | 108 16 0 | Dr. Parsons. |
| Walsingham - - | 6 | 3 | 4 2 0 | 13 15 0 | 31 1 0 | Mr. Thompson. |
| Wareham and Purbeck - | 7 | 1 | — | — | 5 2 0 | Dr. Blaxall. |
| Warminster - - | 5 | 4 | 2 14 0 | 10 1 0 | 21 7 0 | Do. |
| Warrington - - | 3 | 3 | 9 17 0 | 162 7 0 | 219 1 0 | Mr. Thompson. |
| Wayland - - - | 2 | 1 | — | — | 19 7 0 | Do. |
| Wellington (Salop) - | 3 | 2 | 24 10 0 | 26 1 0 | 50 11 0 | Dr. Parsons. |
| Wells (Som.) - - | 4 | 3 | 6 2 0 | 13 4 0 | 30 13 0 | „ Blaxall. |
| Wem - - - | 4 | 2 | 2 2 0 | 5 13 0 | 7 15 0 | „ Parsons. |
| Weobly - - - | 3 | 1 | — | — | 5 11 0 | Mr. Spear. |
| West Bromwich - - | 5 | 5 | 23 14 0 | 43 0 0 | 182 18 0 | Dr. Parsons. |
| Westbury and Whorwelsdown. | 4 | 2 | 2 10 0 | 3 6 0 | 5 16 0 | „ Blaxall. |
| West Derby - - | 7 | 6 | 28 10 0 | 169 16 0 | 407 12 0 | „ Airy. |
| West Ham - - | 9 | 8 | 16 5 0 | 84 18 0 | 437 13 0 | Do. |
| Westminster - - | 1 | — | — | — | — | Do. |
| Weymouth - - | 6 | 5 | 2 9 0 | 15 8 0 | 34 1 0 | „ Blaxall. |
| Whitby - - - | 4 | 1 | — | — | 8 16 0 | „ Barry. |
| Whitchurch (Hants) - | 3 | 2 | 4 13 0 | 7 3 0 | 11 16 0 | Mr. Sweeting. |
| Whitchurch (Salop) - | 4 | 4 | 0 8 0 | 11 3 0 | 19 14 0 | Dr. Parsons. |
| Whitechapel - - | 1 | 1 | — | — | 108 12 0 | „ Airy. |
| Whittlesey - - | 2 | 1 | — | — | 9 9 0 | Do. |
| Wigan - - - | 9 | 6 | 11 5 0 | 92 3 0 | 349 12 0 | Mr. Thompson. |

| UNION. | No. of Vaccination Districts in the Union. | No. of Public Vaccinators recommended for Award. | Range of Awards in each Union. | | Total Sum awarded in each Union. | Medical Inspector. |
|---|---|---|---|---|---|---|
| | | | Minimum. | Maximum. | | |
| | | | £ s. d. | £ s. d. | £ s. d. | |
| Wight, Isle of - - | 9 | 3 | 4 3 0 | 21 5 0 | 36 0 0 | Mr. Sweeting. |
| Wilton - - - | 4 | 2 | 3 6 0 | 8 13 0 | 11 19 0 | Dr. Blaxall. |
| Wimborne and Cranborne. | 4 | 1 | — | — | 15 6 0 | Do. |
| Wincanton - - | 6 | 1 | — | — | 6 18 0 | Do. |
| Winchester, New - | 4 | 3 | 8 0 0 | 31 11 0 | 47 17 0 | Mr. Sweeting. |
| Winslow - - - | 3 | 3 | 3 19 0 | 7 0 0 | 16 16 0 | Dr. Bruce Low. |
| Wirrall - - - | 4 | 3 | 10 14 0 | 24 9 0 | 53 1 0 | Mr. Sweeting. |
| Wisbeach - - - | 14 | 6 | 1 19 0 | 17 0 0 | 35 14 0 | Dr. Airy. |
| Witney - - - | 4 | 1 | — | — | 14 1 0 | „ Blaxall. |
| Woburn - - - | 3 | 3 | 3 6 0 | 7 12 0 | 16 4 0 | „ Bruce Low. |
| Wolstanton and Burslem. | 3 | 3 | 28 3 0 | 43 4 0 | 108 17 0 | „ Parsons. |
| Wolverhampton - - | 5 | 1 | — | — | 22 5 0 | Do. |
| Woodstock - - | 5 | 1 | — | — | 5 15 0 | „ Blaxall. |
| Worcester - - - | 1 | 1 | — | — | 45 11 0 | Mr. Spear. |
| Wortley - - - | 4 | 3 | 28 5 0 | 58 10 0 | 120 13 0 | Dr. Barry. |
| Wycombe - - - | 10 | 6 | 3 10 0 | 17 8 0 | 59 9 0 | „ Bruce Low. |
| Yarmouth, Great - | 1 | 1 | — | — | 43 8 0 | Mr. Thompson. |
| Yeovil - - - | 7 | 6 | 2 14 0 | 12 1 0 | 37 15 0 | Dr. Blaxall. |
| York - - - | 6 | 3 | 2 14 0 | 131 13 0 | 141 5 0 | „ Barry. |
| Total - - | 1,386 | 876 | — | — | 15,638 3 0 | |

App. A. No. 3.

National Vaccine Establishment.

## No. 3.

## Statistics of the National Vaccine Establishment and Educational Vaccination Stations.

### I.—Staff at end of 1890.

N.B.—The Stations named in *italics* are Educational Vaccination Stations authorised by the Local Government Board.

| Description of Vaccinator. | Name of Vaccinator. | Vaccination Stations. | Days and Hours of Attendance. |
|---|---|---|---|
| Vaccinators supplying lymph for the public service, & salaried from the Parliamentary grant. | 1. Dr. R. Cory | *Surrey Chapel* | Tues., Thurs.; 2. |
| | 2. Mr. W. E. G. Pearse | *Tottenham Court Chapel.* | Mon., Wednes.; 1. |
| Parochial and other Vaccinators not salaried from the Parliamentary grant, but contributing lymph at a fixed rate of payment. | 1. Mr. Ellis S. Guest | *Manchester* | Monday; 2. |
| | 2–6. Dr. Edmund Robinson. | *Birmingham* | Monday, Tuesday, Wednesday } 11.<br>Wednesday; 2.<br>Thursday; 11. |
| | 7. Mr. N. E. Roberts | *Liverpool* | Tuesday; 1. |
| | 8. Mr. E. L. Webb | *Pimlico* | Thursday; 10. |
| | 9. Mr. J. Hawthorn | *Newcastle-on-Tyne.* | Wednesday; 3. |
| | 10. Mr. W. E. G. Pearse | *Westminster* | Tuesday; 10. |
| | 11–12. Mr. E. C. Greenwood | *Marylebone* | Tuesday; 2.<br>Wednesday; 10. |
| | 13. Mr. J. Loane | *Whitechapel* | Wednesday; 11. |
| | 14. Mr. Frederick Holmes | *Leeds* | Tuesday; 2.30. |
| | 15. Dr. Edward Lynes | Coventry | Tuesday; 12. |
| | 16–17. Dr. Hugh Thomson | *Glasgow* | Monday; 2.<br>Mon., Thurs.; 12. |
| | 18. Mr. J. F. Staines | *Endell Street* | Tuesday; 10. |
| | 19. Mr. W. Skinner | *Sheffield* | Tuesday; 3. |
| | 20. Dr. A. C. Clarke | Salford | Thursday; 2. |
| | 21. Dr. G. A. Miskin | Waterloo | Tuesday; 2. |
| | 22. Dr. J. B. Buist | *Edinburgh* | Thursday; 3. |
| | 23. Dr. R. Cory | *St. Thomas's Hosp.* | Wednesday; 11.30. |
| | 24. Mr. Wm. McLennan | *Glasgow West* | Monday; 1. |
| Teachers of Vaccination not supplying ymph. | Dr. W. Husband | *Edinburgh* | Wednes., Sat.; 12. |
| | Mr. H. Lawrence | *Bristol* | Wednesday; 10. |
| | Mr. William A. Budd | *Exeter* | Thursday; 3. |
| | Mr. V. A. Jaynes | *Horsleydown* | Wednesday; 3. |
| | Dr. A. N. Montgomery | *Dublin* | Tues., Fri.; 10. |
| | Dr. R. Cory | *Cambridge* | Friday; 11. |

## II.—Animal Vaccine Station.

The Animal Vaccine Station is at 95, Lamb's Conduit Street, where Dr. R. Cory and Mr. T. S. Stott attend for the Vaccination of Children on Tuesdays and Thursdays, at 10.30 a.m.

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## III.—Sources and Amount of Lymph Supply in 1890.

N.B.—The Stations named in *italics* are Educational Vaccination Stations authorised by the Local Government Board.

| Description of Vaccinators. | Vaccination Stations. | Number of Vaccinations performed at the Stations respectively. | | Number of Charges of Lymph supplied from the Stations respectively. | |
|---|---|---|---|---|---|
| | | Primary. | Re-vaccinations. | Charged Ivory Points. | Charged Tubes each estimated as equal to 10 Ivory Points. |
| Vaccinators salaried from the Parliamentary grant. | 1. *Surrey Chapel* | 207 | 17 | 834 | — |
| | 2. *Tottenham Court Chapel.* | 359 | 11 | — | 79 |
| | Total - | 566 | 28 | 834 | 79 |
| Parochial and other Vaccinators not salaried from the Parliamentary grant, but contributing lymph at a fixed rate of payment. | 1. *Manchester* - | 1,168 | — | — | 298 |
| | 2–6. *Birmingham* - | 3,699 | 112 | — | 1,186 |
| | 7. *Liverpool** - | — | — | — | — |
| | 8. *Pimlico* - - | 297 | 22 | — | 23 |
| | 9. *Newcastle-on-Tyne.* | 504 | 101 | — | 54 |
| | 10. *Westminster* - | 653 | 37 | — | 166 |
| | 11–12. *Marylebone* | 891 | 135 | — | 10 |
| | 13. *Whitechapel* - | 2,009 | 5 | — | 386 |
| | 14. *Leeds* - - | 850 | 8 | — | — |
| | 15. Coventry - | 841 | 11 | — | 906 |
| | 16–17. *Glasgow* - | 1,379 | 15 | — | 342 |
| | 18. *Endell Street* - | 206 | 3 | — | 12 |
| | 19. *Sheffield* - - | 944 | — | — | — |
| | 20. Salford - - | 610 | — | — | 263 |
| | 21. Waterloo - | 1,340 | 4 | — | 1,487 |
| | 22. *Edinburgh* - | 388 | 10 | — | — |
| | 23. *St. Thomas's Hospital.* | 269 | 2 | — | 3 |
| | 24. *Glasgow West*† | 379 | 7 | — | 7 |
| | Total - | 16,427 | 472 | — | 5,143 |
| | Grand Total | 16,993 | 500 | 834 | 5,222 |

* Mr. N. E. Roberts was appointed to this station 20th December 1890.
† For eight months only.

App. A. No. 3.

National Vaccine Establishment.

## III.—Sources and Amount of Lymph—*continued.*

During the year, additional supplies (to the extent of 5,821 charged tubes) were obtained from the following gentlemen :—

Dr. W. H. Kempster, Battersea East.
Mr. N. E. Roberts, Toxteth Park.
Dr. T. N. Orchard, Pendleton.
Dr. T. M. Johnson, Salford.
Dr. J. W. Kay, St. George's East.
Mr. J. Bark, Kirkdale.
Dr. R. S. Archer, Everton.
Dr. F. Cadell, Edinburgh.
Mr. A. Meeson, Toxteth Park.
Mr. A. Blackmore, Manchester.
Dr. R. F. Cook, Gateshead.
Dr. G. A. Miskin, Kennington.
Dr. J. Wills, Old Kent Road.

## IV.—Distribution of Human Lymph, 1890.

Number of applications :

| | |
|---|---|
| From Medical Practitioners in England and Wales | 5,447 |
| „ „ „ Scotland | 227 |
| „ the Army | 46 |
| „ the Navy and from the Emigration Department | 50 |
| „ India and the Colonies | 129 |
| „ Diplomatic and other Foreign Services | 40 |
| Total | 5,939 |

Supplies sent out :—

| | |
|---|---|
| Charged ivory points | 846 |
| „ capillary tubes | 10,258 |

## V.—Distribution of Calf-Lymph, 1890.

| | |
|---|---|
| Number of applications | 3,283 |
| Supplies received :— | |
| Charged ivory points | 14,128 |
| „ capillary tubes | 129 |
| Supplies sent out :— | |
| Charged ivory points | 13,255 |
| „ capillary tubes | 129 |

No. 4.



Report on the Operations of the Animal Vaccine Station at Lamb's Conduit Street during the Year 1890–91; by Dr. Cory.

During the year 1st April 1890 to 31st March 1891, 280 calves were received at Lamb's Conduit Street. All of them (males 212, females 68) were vaccinated for the purposes of the station.

The aggregate weight on reception at Lamb's Conduit Street of the 280 calves, was, males 59,376 lbs., females 18,524 lbs. On dismissal from the station their weight was respectively 61,842 lbs. and 19,170 lbs., so that during retention for vaccination purposes calves of both sexes gained considerably in weight, males by an average of 11·63 lbs., females by an average of 9·5 lbs.

Of the above calves, 268 were vaccinated with lymph directly derived from other calves, and 12 were vaccinated with calf lymph which had been stored. As usual, vaccinations performed with stored lymph proved much less successful than the others, 594 insertions of stored lymph producing no more than 465 vesicles, whereas 15,699 insertions in 268 calf-to-calf operations produced 15,232 vesicles; rates of insertion success respectively of 78·28 and 97·0 per cent. No material difference in the result of calf-to-calf vaccinations was observed, whether the lymph used was from calves vaccinated 96 or from calves vaccinated 120 hours previously; in both cases, 106 calves in the one 162 in the other, the rate of insertion success was practically 96·6 per cent.

*Primary Vaccinations.*—During the year 1890–91, 7,220 persons received primary vaccination at the station, five separate insertions of lymph being made in each instance. Of these, 3,687 were males, 3,533 females. All but 39 of the 7,220 primary vaccinations succeeded at the first attempt, and in one case only was a third attempt at vaccination requisite. The amount of insertion success obtained by each of three several operators was as follows:—

Of 661 persons primarily vaccinated by Mr. Stott, 4 failed to return for inspection. Of the remaining 657, 480 were on examination found to have taken in five places, 103 in four, 32 in three, 15 in two, 18 in one, and 9 were not successful on the first attempt; Mr. Stott's insertion success-rate therefore was 89·98 per cent.

Of 474 persons primarily vaccinated by Dr. C. T. Savory, acting for Mr. Stott or myself in the absence of one or other of us, 16 failed to return for inspection. Of the remaining 458, 430 were found to have taken in five places, 19 in four, 6 in three, 3 in one, Dr. Savory's success-rate therefore was 98·1 per cent.

Of 6,085 persons primarily vaccinated by myself, 66 who failed to return for inspection with other 10, all of whom were operated on for the cure of nævi, are not taken into account in these statistics. Of the remaining 6,009, 5,484 were found to have taken in five places, 292 in four, 120 in three, 53 in two, 30 in one, and 30 were not successful on the first trial, an insertion success-rate of 96·8 per cent.

*Re-vaccinations.*—These during the year numbered 478. Mr. Stott performed 87, Dr. Savory 2, and I myself 389. Of my 389 cases, 336 were successful in five places, 24 in four, 9 in three, 5 in two, 3 in one, and 1 was unsuccessful at first trial. Other 11 did not return for inspection. My insertion success-rate therefore in re-vaccination was

96·1. Mr. Stott's success-rate among the 79 of his revaccinations that returned for inspection was 97·87, and Dr. Savory's 100 per cent.

Of the 7,698 persons vaccinated or re-vaccinated at the station, 44 only returned thereto after "inspection" on account of some abnormal course of their vaccination. As in former years, the abnormality consisted in most cases of sore arm resulting from ignorant treatment of the vesicles or of the scabs. For the rest there were :—3 cases of transient eruption, 2 cases of axillary abscess (both following sore arm), and 3 cases of erysipelas (also complicating sore arms). No death occurred.

## No. 5.

### On the Subject of Isolation Hospital Provision in the Keighley Union; by Dr. Barry.

In consequence of a communication made to the Local Government Board by the guardians of the Keighley Union, I received instructions on February 7th to attend a conference between the guardians and the local authorities of the several sanitary districts comprised within the Union, on the subject of isolation hospital provision. The conference was held on Wednesday, February 12th, and, although nothing definite was then decided upon (the meeting being adjourned for a month to allow the delegates to discuss the matter), it may be useful for me to state the nature of the proposals made by the guardians, and also to give some account of the circumstances of the districts, with notes as to their past history as regards the prevalence of infectious diseases, and suggestions as to the arrangements which, in my opinion, appear to be best calculated to secure efficient isolation of such diseases.

The nature of the proposals made by the Keighley guardians, and the reasons given by them for convening the conference will be gathered from their letter addressed to the Board on January 11th, 1890, in which the guardians say that "they have had under consideration the " inadequate provision made within the Union for the treatment of " cases of infectious disease.

" There is not in the several districts comprised within the Union any public hospital or place for the reception of persons suffering from infectious disease other than the infectious ward of the workhouse infirmary. The population of the Union according to the Census of 1881 was 61,121, and is now probably over 70,000.

" It comprises the districts of the following sanitary authorities, namely :—

" The Corporation of the Borough of Keighley;
" The Bingley Improvement Commissioners;
" The Bingley Township Local Board;
" The Haworth Local Board;
" The Oxenhope Local Board;
" The Oakworth Local Board;
" The Keighley Union Rural Sanitary Authority.

" These districts include the whole of the Union, and do not extend beyond the Union.

" The guardians consider it desirable that all the Sanitary Authorities should combine and provide one hospital for the use of all their districts, which hospital should also receive all cases of infectious disease occurring amongst persons receiving relief, whether inside or outside the workhouse."

It is probable that the guardians were influenced in making this proposal by a resolution passed at the Poor Law Conference for the

Yorkshire district, held at Harrogate on November 14th, 1889, to the effect that it was the duty of Sanitary Authorities (as distinguished from Poor Law Authorities) to provide hospital accommodation for the isolation of all cases of infectious disease occurring within their respective districts.

Before commenting on the proposal of the guardians I think it may be useful to refer briefly to the situation and topography, population, house accommodation, industries, and the amount and character of the prevalent infectious diseases of the district.

*Situation and Topography.*—From an examination of the diagram map opposite, it will be seen that the Keighley Union is a compact district, bounded on the N.W. by the Skipton Union, on the N.E. by the Wharfedale Union, on the S.E. by portions of the North Bierley and Bradford Unions, on the S. by the Halifax Union, on the S.W. by the Todmorden Union, and on the W. by the Burnley Union (Lancashire). The river Aire passes through the northern part of the district, from W. to E., and is joined by the river Worth about a mile N.E. from the centre of the Borough of Keighley. The Worth takes its rise from numerous streams in the Oxenhope, Haworth, and Oakworth Sanitary Districts, and flows in a north-easterly direction through portions of the Oakworth, Bingley Township, and Keighley Urban Districts.

The Union generally is very hilly, much of it to the south-west and north-east consisting of wild moorland, and considerable portions of all the districts, except Keighley and Bingley Urban, are comparatively sparsely populated. The chief centres of population are situate either in the Aire or the Worth valleys.

The several sanitary districts comprised within the Union are very varied in shape and size. The Keighley Rural Sanitary District consists of three townships, of which two, Sutton and Steeton, are situate to the N.W. of the Union, on the south side of the Aire valley, whilst the third, Morton, separated from the last named by a portion of the Silsden Urban District, in another Union, is situate on the north side of the Aire valley. The Borough of Keighley is comprised within a circular area, the boundary being formed by a circle having a radius of one mile from the parish church as a centre. This circle is broken into on the south side by a projecting portion of the Bingley Township Urban District. This Bingley Township Urban Sanitary District consists of the large parish of Bingley, with the exception of the central town of Bingley (and a small irregular area surrounding that town), which is under Improvement Commissioners as Sanitary Authority. The Oakworth Urban Sanitary District is a large semi-rural district, consisting of all that portion of the Keighley parish not comprised within the Borough of Keighley. Haworth and Oxenhope Urban Sanitary Districts are both very hilly, and are situate at the head of Worth valley. All the principal towns and villages are connected with Keighley by means of good roads, although these have in many instances steep gradients. From a further examination of the diagram map it will be seen that in all the districts to the S.W., S., and S.E. of the

# SANITARY DISTRICTS IN KEIGHLEY UNION (SHOWN BY CROSS HATCHING) WITH NEIGHBOURING DISTRICTS AND THEIR ISOLATION HOSPITAL PROVISION.

*Scale of 4 Miles to an inch.*

*Boundary of Hospital District.*
*Boundaries of Districts having user of Hospitals.*

*Hospital at work ■; in construction ☒; plans prepared □*

Judd & Co Lith. 73 & 75, Farringdon Rd 2533. 6. 91

Keighley Union the Sanitary Authorities have either made, or are in process of making, provision for the isolation of infectious diseases occurring in their respective districts. No such provision has been made in the case of the adjoining northerly districts.

*Population.*—The total population in 1881 of the sanitary districts concerned was 61,121, having increased by 17·2 per cent. (from 52,141) during the preceding 10 years. If the same rate of increase has been maintained during the last nine years, the population may now (1890) be estimated at about 70,000. The ratio of increase between 1871 and 1881 was, however, very unequal in the different districts. It was most marked in the Haworth Urban, 32·4 per cent.; Bingley Urban, 30·2 per cent.; and Keighley Urban, 27·7 per cent. On the other hand, in the Oxenhope Urban, the ratio of increase was but 4·9 per cent.; in the Bingley Township Urban, 4·4 per cent.; and in the Oakworth Urban, 1·3 per cent.; whilst in the Keighley Rural Sanitary District there was an actual decrease of 1·8 per cent.

*House Accommodation.*—A considerable proportion of the houses throughout the whole district are, in accordance with a custom which prevails in this part of Yorkshire, built *back-to-back*, and this is especially the case in the Keighley and Bingley Urban Districts. With regard to certain portions of other districts, I am able to give some exact information as to the house accommodation, from reports made by the respective Medical Officers of Health, after house-to-house surveys.

In the Keighley Rural Sanitary District special reports were made in 1879 with respect to the township of Morton and Sutton. In Morton it was found that of a total of 458 houses, having a population of 2,151, 38 were back-to-back and 320 were unprovided with back doors; that 166 houses, with 675 inmates, possessed each one bedroom only, and 18 houses, having 48 inmates, had each one room only for all purposes.

In Sutton, of a total number of 384 houses, having a population of 1,600, 80 were back-to-back, and 120 were unfurnished with back doors, whilst 116 houses, having 364 inmates, possessed each one bedroom only.

With regard to the Oakworth Urban Sanitary District, a special survey of the villages of High and Low Utley was made in 1884, and a summary of the results obtained is contained in the Annual Report of the Medical Officer of Health for that year. From this it appears that of a total number of 120 houses, with a population of 432 persons, comprised within this portion of the Oakworth District, 49 were back-to-back, 29 (with 97 inmates) had each only one bedroom, whilst four houses had each only one room for all purposes.

With regard to the Bingley Township Urban Sanitary District, a special survey of the Hainworth Ward, or Worth valley portion of the district, was made in 1885, and a summary of the results obtained is contained in the Annual Report of the Medical Officer of Health for that year. From this it appears that of a total of 779 inhabited houses,

with a population of 4,314 persons, contained within the district, 233 houses, with 838 inmates, possessed each one bedroom only, whilst 21 houses, with 41 inmates, had each one room only for all purposes.

A special survey of the Haworth Urban Sanitary District was made in 1886–87, and from the special report made by the Medical Officer of Health it would appear that of a total number of 936 houses having a population of 4,153, no less than 231 were back-to-back, 54 were cellar dwellings without means for through ventilation, 60 houses although not back-to-back were of the "salt box" pattern, and were also unprovided with means for through ventilation, and 157 houses were unfurnished with back doors; 278 houses, having 961 inmates, each possessed only one bedroom, and 42 houses with 78 inmates had each one room only for all purposes.

There is no reason to believe that any considerable proportion of the house accommodation in those districts and portions of districts not specially reported upon is of a better class than that referred to above, and the impossibility therefore of effectually dealing with outbreaks of infectious disease in such districts, in the absence of isolation hospital provision, becomes sufficiently evident.

Apart from the question of house accommodation, the habits of the people in this Union, as in other and neighbouring districts upon which I have previously reported, are such as to afford exceptional facilities for the spread of infectious disease when once introduced into a district.

*Industries.*—Wool spinning (Bradford trade) is the staple industry of the district, and mills for this purpose are found in nearly all the towns and larger villages. In the Keighley Urban Sanitary District a considerable number of the inhabitants are employed in machine-making —more especially washing and wringing machines. Large paper-mills exist in the Oakworth Urban District. In all the districts, with the exception of the Keighley and Bingley Urban Sanitary Districts, many persons are engaged in agriculture. A large proportion of the hands employed in the woollen and paper-mills are women and girls.

*Mortality and Prevalence of Infectious Disease.*—In Table I.* the number of deaths from (*a*) all causes; (*b*) small-pox; (*c*) scarlatina; (*d*) diphtheria and croup; and (*e*) "fever," for each separate district (with the exception of the Bingley Urban Sanitary District) for the last 10 years, is given, together with extracts from the reports of the Medical Officers of Health as to the prevalence of infectious diseases for the same years. No information is given with regard to the Bingley Urban Sanitary District, as the Medical Officer of Health, who was appointed in 1874, is not under the Board's Order, and consequently no reports have been furnished to the Board.

In the last of the statistical columns is also shown the number of non-pauper cases removed to the "infectious wards" of the Keighley Workhouse during successive years from each of the districts.

* * * * *

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* Not here reproduced.

An examination of the figures in the table, together with the extracts from the Medical Officers of Health's Reports, will at once show that scarlatina has prevailed in a more or less epidemic form from time to time during the period of 10 years, 1879–88, in each of the districts, and that in some of the districts this disease has been present almost year by year; that non-spasmodic croup (which without doubt is frequently synonymous with diphtheria) has caused a considerable number of deaths in the Keighley and Oakworth Urban and Keighley Rural Districts: that in the larger urban districts deaths from enteric fever have been registered yearly, whilst in the smaller districts outbreaks of the same disease have occurred from time to time; and that, although only four deaths are recorded as due to small-pox, this disease has been introduced into the district on several occasions. Small-pox appears to have been the only disease for which habitual use has been made of the "infectious wards" of the Keighley Workhouse. It must be remembered in this connexion that the inhabitants of Keighley and the neighbouring districts, from their opposition to vaccination, have to rely upon prompt isolation to prevent the spread of small-pox. From the small number of cases of other diseases actually removed to the workhouse hospital, it will be seen that there has been no systematic endeavour made to check the spread of other infectious disease in any one of the seven districts by means of isolation.

The necessity for isolation provision, as will be seen from the extracts given in the table, has been referred to over and over again by the Medical Officers of Health for all the districts of which we have any records. In 1879 the Medical Officer of Health for the Keighley Rural Sanitary District pointed out how little could be done to limit the spread of infectious disease in the absence of standing means for isolation; and the provision of a hospital in that district has been repeatedly urged.

In the Oakworth, Oxenhope, and Haworth Urban Districts the necessity for hospital provision has been pointed out in recent annual reports, and the combination of these with adjoining districts for hospital purposes has been suggested.

In the Keighley Urban District the necessity for hospital provision was specially noticed in the annual report of the Medical Officer of Health for 1883, and in each year since 1885 isolation provision has not only been recommended by the Medical Officer of Health, but its necessity has also been urged by the Sanitary Committee of the Corporation.

In the Bingley Township Urban District the necessity for special provision has been pointed out each year since 1884, and a combination of all the sanitary authorities in the Union has been suggested by the Medical Officer of Health.

*Present means available in the District for dealing with Infectious Disease.*—As stated in the letter of the Keighley Guardians, already

quoted, the only standing means for isolation existing in the Union consist of the "infectious wards" in connexion with the Keighley Workhouse, and although the Guardians have from time to time undertaken the treatment of the non-pauper cases of infectious disease sent to them by neighbouring Sanitary Authorities, they have, I understand, no legal right to do so, and in the case of a serious outbreak of infectious disease in the workhouse, even this resource would fail. But, apart from this, there are grave objections to this use by Sanitary Authorities of premises connected with the relief of the poor. There is naturally great reluctance on the part of persons who are not paupers to being "sent to the workhouse," as they consider it, and consequently an absolute refusal to go to hospital is frequently met with; whereas, if a proper hospital, under the control of the Sanitary Authorities, were available, this difficulty would not exist, and there would be corresponding better chance of securing that efficient isolation which is indispensable for dealing with outbreaks of infectious disease.

I may here note that the Keighley Town Council have recently secured a site for hospital purposes, but have as yet taken no further steps.

There are no standing means for the efficient disinfection of clothing, bedding, &c., in existence in any of the seven districts.

The Infectious Disease (Notification) Act, 1889, has been adopted in the Keighley, Bingley, Oakworth, and Haworth Urban, and in the Keighley Rural Sanitary Districts, but it is evident that information as to sickness can only be serviceable in a limited class of cases, unless provision be made at the same time of adequate means of isolation for the infected sick; the more especially in a district where the nature of the house accommodation is such as has been described in the earlier part of this memorandum.

*Proposed combination of the Districts for Hospital Purposes*—The proposal of the Keighley Guardians that all the Sanitary Authorities in the Union should unite for the purpose of providing hospital accommodation for persons suffering from infectious disease is, as I have already stated, a proposal that has been made on more than one occasion by the local health officers, and after a full consideration of all the circumstances of the districts concerned, I fully concur as to the desirability of such a combination, and consider that by this means the greatest efficiency will be obtained by the least relative expenditure.

In this case all the districts concerned have similar interests; an isolation hospital provided at, or near to, the town of Keighley would be readily accessible as regards all the chief centres of population in the district; and the population to be served is large enough to ensure the hospital being kept in constant use, and consequently always in a state of preparedness for an emergency.

In the following Table II., the area, population in 1881, and present rateable value of the several sanitary districts are given.

## Table II.

Showing Area, Population, and Rateable Value, of the several Sanitary Districts in the Keighley Union.

| Sanitary District. | Area in Acres. | Population, (1881). | Rateable Value (1890). |
|---|---|---|---|
| | | | £ |
| Keighley Rural - - - | 8,187 | 5,416 | 21,814 |
| Keighley Urban - - - | 1,742 | 25,247 | 83,526 |
| Bingley Urban - - - | 909 | 8,972 | 29,723 |
| Bingley Township Urban - - | 9,407 | 9,465 | 32,179 |
| Haworth Urban - - - | 360 | 3,816 | 9,760 |
| Oakworth Urban - - - | 11,905 | 5,762 | 19,867 |
| Oxenhope Urban - - - | 4,259 | 2,443 | 10,398 |
| Totals - - - - | 36,769 | 61,121 | 207,267 |

I assume that in the event of the several Boards agreeing to unite for hospital purposes, a Joint Board would have to be formed under section 279 of the Public Health Act, 1875. In view of the different ratios that prevail between the rateable values and population in the different districts it would probably be found advisable that the cost of buildings, establishment, &c., should be paid out of a common fund contributed by the constituent districts in proportion to their population, on a scheme similar to that in force in the Joint Hospital Districts recently formed in the neighbouring Union of North Bierley.

*Amount of Accommodation required.*—From a consideration of the nature of the house accommodation throughout the district, of the habits of the people, of the great facilities for intercommunication which exist between the districts comprised within the Keighley Union and the populous towns of Leeds, Bradford, and Halifax, as well as of the previous history of the districts with respect to the prevalence of and mortality from infectious disease, I am of opinion that the bed accommodation required for efficient isolation is one bed per 1,000 of the population. Taking the population at the estimate already given, namely, 70,000, this would give 70 beds as the total accommodation required. As, however, systematic isolation has never yet been attempted in the district, and as it will probably take the inhabitants a considerable time to get used to, and to appreciate the benefits of isolation, I have no doubt that a less number than 70 beds would be found sufficient in the first instance. Probably the provision of one ten-bedded isolation ward block, constructed on the lines indicated in Plan D of the Official Memorandum of the Local Government Board, and in which two diseases in both sexes might be simultaneously treated, and also a pair

of ordinary ward blocks, each containing twelve beds, for the treatment of one disease in both sexes; together with the requisite administrative buildings; would at first answer the requirements of the districts.

An efficient apparatus for the disinfection of bedding, clothing, &c., should be provided in connexion with the hospital.

At the conference a suggestion was made that if a Joint Board were formed, it might be found advisable for them to acquire the present Workhouse Infirmary and "infectious wards" which are situated in Fell Lane, at a considerable distance from the workhouse proper. The position of the site would, no doubt, be suited for the proposed purpose, but the present buildings, which are two long, two-storied parallel blocks, with the administration in the centre, would require very extensive alterations to render them fitted for isolation hospital purposes, so that it would probably be found cheaper to erect new buildings altogether, even if the transfer of the establishment from the Poor Law to the Sanitary Authorities could be effected.

From what has been said in the body of this memorandum as to the circumstances of the district, the necessity for isolation hospital provision for the use of the sanitary districts in the Keighley Union will have become evident, as also the fact that it is essential for the public health of the district that steps should be taken to secure such provision for the various constituent places with the least possible delay.

## No. 6.

ABSTRACT of MEDICAL INSPECTIONS and INQUIRIES made in 1890 with regard to the INCIDENCE of DISEASE on particular places, and to QUESTIONS concerning LOCAL SANITARY ADMINISTRATION.



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1. ALVASTON (Derbyshire) ; population (1881), 1,506; Dr. Parsons.

*Sanitary Authority:* Alvaston and Boulton Local Board (U.).*

*Grounds of Inquiry:* Enteric fever and diphtheria.—Registrar-General's Returns.

*Chief Facts reported by Inspector:* An outbreak in summer of enteric fever limited to Bennett Street, New Town, contiguous to Derby, but invading a large proportion of the occupied houses in this street. Sewer and drains here, at date of outbreak, ill-constructed and choked with sediment for want of means of flushing. Water supply, from a number of shallow wells, contaminated by leakage from drains, and, during time of flood, by fœcal matter washed out of the privy cesspits.

A succession of cases of diphtheria later on in different parts of district. This disease apparently propagated by personal communication, especially among children attending the Alvaston National School. Grave sanitary defects at this school.

2. BARNSTAPLE RURAL SANITARY DISTRICT (Devonshire) ; population, (1881), 12,158 ; Dr. R. Bruce Low.

*Sanitary Authority:* Barnstaple R.*

*Ground of Inquiry:* Mortality from diphtheria.—Registrar-General's Returns, and Report of Medical Officer of Health.

*Chief Facts reported by Inspector:* More or less prevalence of diphtheria in various parts of district for last six years. Increased fatality of the disease in 1889, associated with widespread occurrence of cases of so-called mumps. Diffusion of contagion by means of communications of sick and healthy, chiefly through mild or unrecognised cases. The diphtheria not specially incident on populous places where sanitary conditions were far from prefect; isolated farmhouses often attacked.

Some villages not provided with sufficient water supply. Sewerage incomplete or wanting. Byelaws in force for regulating removal of refuse and emptying of privies and cesspools, but not sufficiently enforced by the Sanitary Authority.

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* Throughout this abstract "R." denotes "Rural Sanitary Authority," and "U.," "Urban Sanitary Authority."

3. Barrowby (Lincolnshire) ; population (1881), 807 ; Dr. Parsons.

*Sanitary Authority :* Grantham R.

*Ground of Inquiry :* Local complaint as to water supply, and request for inspection.

*Chief Facts reported by Inspector :* The water supply of the village derived from a number of wells, of depths under 30 ft., sunk in the marlstone (Middle Lias), many of them exposed to contamination from cesspit privies, pigstyes, farmyards, surface water, &c. The water of most samples from time to time analysed, found to be polluted. Repeated outbreaks of enteric fever. Action of the Sanitary Authority in the matter of water supply very inadequate ; confined to requiring the cleaning out of wells found to be polluted. (*See* p. 129 of present volume.)*

4. Berkhampstead (Herts); population (estimated), 5,500 ; Dr. Blaxall.

*Sanitary Authority :* Berkhampstead R.

*Ground of Inquiry :* Diphtheria.—Local information.

*Chief Facts reported by Inspector :* Appearance of sore throat amongst the boys at a grammar school in September 1889, not long subsequent to reassembly of the school after the summer holidays. In October sore throat in one of the day-scholars, followed by typical diphtheria in his family. In December throat illness of an ill-defined character having been meanwhile present at the grammar school, occurrence among the boys of multiple cases of typical diphtheria of a virulent type leading to breaking up of the school on December 14th. This diphtheria limited to families connected with the school. Sanitary condition of the schoolhouse good ; that of the two school boarding-houses and the home of the day scholar first attacked less satisfactory.

Sewerage and drainage of the town very defective. Method of sewage disposal faulty. (*See* p. 79 of present volume.)†

5. Brinkworth (Wilts) ; population (estimated), 1,150 ; Dr. R. Bruce Low.

*Sanitary Authority :* Malmesbury R.

*Ground of Inquiry :* Diphtheria prevalence. — Reports of Medical Officer of Health and local representations.

*Chief Facts reported by Inspector :* Continued prevalence in Brinkworth of sore throat during last three years. Recent increase of severity of cases culminating in epidemic diphtheria. This epidemic widespread, but not of fatal type. Diffusion of the disease by means of school attendance. School not closed at first owing to dispute as to nature of the current malady.

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* Report reprinted as App. A. No. 14 of present volume.
† Report reprinted as App. A. No. 9 of present volume.

Water supply bad; taken from pits dug in clay which collect impurities washed from yards and from cultivated land. Nuisances from privy-pits and from pig-keeping. The Infectious Disease (Notification) Act of 1889 adopted, but no provision made for proper isolation and disinfection.

6. Calver (Derbyshire); population (1890), 386; Dr. R. Bruce Low.

*Sanitary Authority:* Bakewell R.

*Ground of Inquiry:* Choleraic diarrhœa.—Report of Medical Officer of Health.

*Chief Facts reported by Inspector:* Outbreak of choleraic diarrhœa (with jaundice) in an outlying portion of Calver village during April; 51 persons attacked in four weeks. Diarrhœa known to have occurred early in the year in other villages of district, but in a mild form.

First case became ill after visiting a relation some miles off, who was suffering from the malady. Within six days of attack of this first case in Calver, all the members of his household were similarly attacked, and also two families getting milk from this invaded household. The chief group of cases occurred in a row of 12 houses against the north gable of which was built a large uncovered deep midden, having connected with it six privies, and into which bowel discharges from the patients had been thrown. The slop drain at the back of the houses was choked up. The water supply was obtained from a disused lead mine at an inconvenient distance from the houses.

7. Easingwold Rural Sanitary District (Yorks, N.R.); population (1881), 9,533; Dr. Barry.

*Sanitary Authority:* Easingwold R.

*Ground of Inquiry:* High mortality from diphtheria.—Registrar-General's Returns.

*Chief Facts reported by Inspector:* High death-rate from diphtheria in the district, but owing to absence of information with respect to non-fatal throat sickness, no definite conclusion arrived at as to origin. District comprises several scattered villages; agriculture and brick-making the almost exclusive industries. General neglect of Sanitary Authority to carry out their duties under the Public Health Acts. No isolation hospital provision, and no efficient steps taken to prevent the spread of disease. No proper provision of sewerage: villages, as a rule, dependent upon old rubble highway drains for removal of sewage, usually to the nearest water-course. Excrement disposed of in midden privies of defective construction. No system of scavenging. Water supplies, obtained from wells sunk in the Drift, or Lias shales, frequently exposed to dangerous

pollution ; in some places scanty in quantity and situate at an unreasonable distance from dwellings. A large proportion of cottages insufficiently ventilated and damp. Many old houses, some quite unfit for habitation. No urban powers. Dairies and cowsheds not inspected.

8. Hastings (St. Mary in the Castle Sub-District) ; (Sussex) ; population (1881), 35,669; Mr. Spear.

*Sanitary Authorities :* Hastings R. and Hastings U.

*Ground of Inquiry :* Diphtheria.—Registrar-General's Returns.

*Chief Facts reported by Inspector :* Diphtheria prevalence, most fatal during the second quarter, in and about Silverhill, a suburb of Hastings situated in the Rural District. The disease mainly affecting children in attendance at particular elementary schools. Sanitary state of Silverhill not satisfactory. Construction of dwellings not under regulation ; drains defective and wanting ventilation ; closets unsupplied with water ; public water service intermittent.

9. Neath Rural Sanitary District (First Division) ; (Glamorgan) ; population (estimated), 13,300 ; Mr. Spear.

*Sanitary Authority :* Neath R.

*Ground of Inquiry :* Scarlatina.—Report of Medical Officer of Health.

*Chief Facts reported by Inspector :* Sustained prevalence of scarlatina ; at first mild, afterwards very severe and fatal. Of 181 attacks and 31 deaths occurring in this Division in the first 9½ months of 1890, no less than 81 and 21 respectively in the village of Coedfranc having a population of 4,400 only. Sanitary administration of Division lax and inefficient. Certificates received under Notification Act simply filed ; invaded houses not visited by Medical Officer of Health until deaths occurred in them ; disinfection only occasionally practised. No proper measures for limiting spread of infection through schools. (*See* p. 91 of present volume.)*

10. Northop Hall (Flintshire) ; population (estimated), 400–500 ; Mr. Spear.

*Sanitary Authority :* Holywell R.

*Ground of Inquiry :* Enteric fever.—Report of Medical Officer of Health.

*Chief Facts reported by Inspector :* Localised outbreak of enteric fever in a small colliery hamlet under circumstances exceptionally favourable to spread of disease of this class. Every sort of unwholesome condition present, including overcrowding of small badly ventilated cottages and, as well, entire absence of any sort of care by the Sanitary Authority for treatment of

* Report reprinted as App. A. No. 11 of present volume.

the sick persons. This left to charity, which provided a trained nurse who did what she could in the overcrowded dwellings of the sick. (*See* p. 133 of present volume.)*

11. Oakley, Brome, Scole, Bressingham, Kenton, Great Horkesley, Althorne, Willingham, Holbeach, and Gedney Hill (Suffolk, Norfolk, Essex, and Lincs.) ; Dr. R. Bruce Low.

*Sanitary Authorities:* Depwade, Gainsborough, Hartismere, Holbeach, Lexden and Winstree, Maldon, Oundle, and Plomesgate R., and Holbeach U.

*Ground of Inquiry:* Cerebro-spinal meningitis.—Local information and Reports of Medical Officers of Health.

*Chief Facts reported by Inspector: Oakley and Brome.*—During month of July, 14 cases with one death were noted. All cases were children under 12 years. Multiple cases occurred in four families. Origin of outbreak obscure. No evidence of diffusion of the disease by the usual ways in which infectious diseases are known to spread. No connexion traced with sanitary defects, nor with improper food.

*Scole and Bressingham.*—Five cases of cerebro-spinal fever noted during August and early part of September just after the outbreak at Oakley and Brome. No definite connexion traced between the two outbreaks, though inter-communication is abundant between the two localities, which are only divided by the River Waveney. Two of the cases at first diagnosed as sunstroke, but afterwards regarded as having been examples of cerebro-spinal fever. Other cases probably occurred but were unrecognised. No satisfactory evidence found to explain mode of origin or spread of the disease.

*Other parishes* (see above list).—Scattered cases of cerebro-spinal meningitis met with during second half of 1890. Some fatal, others non-fatal. No apparent connexion between the cases traced. Mild attacks probably escaped observation or were classed as sunstroke or the like. (*See* p. 117 of present volume.)†

12. Pemberton (Lancs.) ; population (1889), 17,000; Mr. Spear.

*Sanitary Authority:* Pemberton U.

*Ground of Inquiry:* Outbreak of enteric fever.—Report of Medical Officer of Health.

*Chief Facts reported by Inspector:* A smart epidemic of enteric fever almost confined to the village of Lamberhead Green (in the Pemberton and Orrell Sanitary Districts), affecting the youthful population (4–16) of both sexes, and practically limited to the first fortnight of August. The village under two separate systems of sewers, each of which embraced districts not affected by the epidemic. Water supply in use, distributed over a much wider area. Method of excrement disposal (by privy-middens) objectionable, but not serving to account for the sudden and widespread fever outbreak ;

* Report reprinted as App. A. No. 15 of present volume.
† Report reprinted as App. A. No. 13 of present volume.

neither school attendance nor milk supply implicated. On July 22nd, at the village fair, most, if not all, of the early sufferers drank ginger beer, and ate "pease pudding," that had been made in a room where a child was actually suffering from enteric fever.

13. Pembroke Rural Sanitary District (Pembrokeshire); population (1881), 11,441; Mr. Spear.

*Sanitary Authority:* Pembroke R.

*Ground of Inquiry:* Further information desired by the Board as to action of the Authority in regard of unwholesome conditions in the District reported in 1880 and 1885 by Inspectors of the Medical Department; also particulars as to local circumstances of Llanstadwell with reference to byelaws proposed for that contributory place.

*Chief Facts reported by Inspector:* The Authority, itself lax and inactive, inadequately informed and advised by its officers as to the pressing needs of its district. As regards Llanstadwell, need for the Sanitary Authority itself undertaking systematic cleansing of privies and ashpits, and need especially for building byelaws. (*See* p. 151 of present volume.)*

14. Rawdon (Yorks., W.R.); population (1881), 3,047; Dr. Barry.

*Sanitary Authority:* Rawdon U.

*Grounds of Inquiry:* Local complaints and need for fuller information concerning sanitary condition of the District.

*Chief Facts reported by Inspector:* Sanitary administration most inefficient—practically non-existent. During eleven years one sewer constructed with a view to silencing a particular complainant. Greater portion of district either unsewered, or highway drains made use of for conveying sewage directly into streams. House drainage very defective. Water supply provided by private enterprise fairly satisfactory. Excrement disposed of in faultily constructed midden-privies, which are a source of considerable nuisance. Scavenging left to occupiers and neglected. Streets other than main roads unmade and undedicated. Erection of new houses on back-to-back plan allowed, notwithstanding the fact that building byelaws based on the Board's model series are nominally in force in the district. Byelaws not enforced in other respects. Cowsheds badly kept. No isolation hospital or disinfecting apparatus. Infectious Disease (Notification) Act of 1889 not adopted. High death-rate from enteric fever. (*See* p. 141 of present volume.)†

15. Runcorn (Lancashire); population (estimated), 18,000; Mr. Spear.

*Sanitary Authority:* Runcorn U.

*Ground of Inquiry:* "Fever" prevalence.—Registrar-General's Returns.

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* Report reprinted as App. A. No. 18 of present volume.

† Report reprinted as App. A. No. 17 of present volume.

*Chief Facts reported by Inspector:* Enteric fever epidemic in 1884, 1887, and 1889. In the recent outbreak spread of the fever associated (as formerly) with excremental contamination of the air by large, deep, ill-placed midden-privies believed to have received bowel discharges of antecedent cases of the disease. Midden-privies in process of modification, but new pattern not satisfactory. Trough waterclosets adopted for a limited area only. Emptying of middens done under contract; work irregularly performed, often not until midden has been complained of by householder or by Inspector of Nuisances.

16. Scotter (1,070); Scotton (260); and Messingham (1,132); (Lincolnshire); Dr. Parsons.

*Sanitary Authorities:* Gainsborough and Glanford Brigg R.

*Ground of Inquiry:* Epidemic of pneumonia.—Local information and request for investigation.

*Chief Facts reported by Inspector:* A series of cases marked by the symptoms and physical signs of pneumonia, but accompanied by vomiting and in some cases by diarrhœa. The malady very fatal, especially among old people, death resulting in 60 per cent. of the cases. The sputa of some of the cases administered to mice killed these animals, and in their bodies the Middlesbrough pneumonia bacillus was found. Concurrently with the pneumonia cases there was a general prevalence, especially among school children, of vomiting and diarrhœa. Pneumonia attacks in Scotter especially numerous along the course of a particular sewer. Evidence also of the spread of the disease by infection.

Sewers and house drains in Scotter and Scotton defective and untrapped, unprovided with ventilation or means of flushing. Water supply exposed to risk of contamination. (*See* p. 95 of present volume.)*

17. Sculcoates Rural Sanitary District (Yorks., E.R.); population (1881), 8,670; Dr. Barry.

*Sanitary Authority:* Sculcoates R.

*Ground of Inquiry:* Enteric fever.—Reports of Medical Officer of Health and local complaint.

*Chief Facts reported by Inspector:* Enteric fever epidemic, in the villages of Sutton, Hessle, North Ferriby, and West Ella, associated with specific pollution of wells, whence water supply obtained.

District inspected in 1877 by Dr. Blaxall on account of diphtheria prevalence, and in 1881 by Dr. Airy on account of scarlet fever prevalence.

Water supply chiefly obtained from wells, in many instances liable to dangerous contamination. Portions only of district supplied from Hull Corporation Waterworks. Excrement

* Report reprinted as App. A. No. 12 of present volume.

disposed of in small middens constructed on Hull system. Scavenging, carried out periodically by contractors under Sanitary Authority, efficiently performed. Sewerage as a rule of a makeshift character; highway drains frequently utilized for the purpose, and the sewage discharged into the nearest watercourse. Sewers generally unprovided with proper means of ventilation or of flushing. House drains very defective. Many houses damp from want of proper surface drainage and from absence of eavespouts. Supervision of construction of new buildings, drains, &c., very lax. Compulsory notification of infectious diseases in force, but no isolation hospital or proper means of disinfection provided.

18. Staines Rural Sanitary District (Middlesex); population (estimated), 21,400; Dr. Blaxall.

*Sanitary Authority:* Staines R.

*Ground of Inquiry:* Need for information respecting the sanitary administration and condition of the district.

*Chief Facts reported by Inspector:* Almost total absence of proper sewerage and drainage; cesspit privies in general use; excremental and slop nuisances prevalent throughout the district; water supplies exposed to dangerous pollution. The subsoil water of the district passing into and out of privy pits and cesspools before gaining entry to the Thames in the vicinity of (and above) the intakes of certain water companies supplying large areas of the metropolis. Gross sanitary evils of the older parts of the district perpetuated in new dwellings and their precincts.

No byelaws in force for the regulation of the construction of new dwellings, keeping of slaughter-houses, pigs, &c. Inefficient inspection of cow-sheds, dairies, and milkshops.

Refusal of the Authority to complete the erection of an isolation hospital, which they, together with the Urban Authority of Staines, had commenced to build, and for which a loan had been sanctioned by the Local Government Board. Urgent need of hospital accommodation for cases of infectious disease, shown by the continued presence of such disease in the district, often in an epidemic form. The Authority incurring useless expenditure (so far as stopping the spread of disease is concerned) in providing nurses, food, &c., for infected sick in their cottages. (*See* p. 51 of present volume.)*

19. Stalybridge (Cheshire); population (estimated), 28,000; Mr. Spear.

*Sanitary Authority:* Stalybridge U.

*Ground of Inquiry:* Mortality from diphtheria and "croup."—Report of Medical Officer of Health.

*Chief Facts reported by Inspector:* High mortality from diphtheria and "croup." Long continued high general and

* Report reprinted as App. A. No. 7 of present volume.

infant mortality. Endemic prevalence of enteric fever. Many cases of so-called croup, undoubtedly diphtheritic; and continued, though not large, prevalence of this disease. Evidence as to a common source of infection and as to spread of the malady from person to person negative in character. A large proportion of the cases in houses exposed to the invasion of sewer air. Sanitary condition of the town unsatisfactory as regards sewerage, drainage, house accommodation, and method of excrement and refuse disposal. Lodging houses, slaughter-houses, and dairies ill-regulated. Sanitary department in need of organization. Ineffective dealing with spreading disease. (*See* p. 85 of present volume.)*

20. Tees Valley (Yorks. N.R., and Durham); population (1881), upwards of 400,000; Dr. Barry.

*Sanitary Authorities:* Barnard Castle, Darlington, Eston, Kirkleatham, Middlesbrough, Normanby, Ormesby, South Stockton, Stockton-on-Tees U., Darlington, Stokesley, Stockton, and Teesdale R.

*Ground of Inquiry:* Enteric fever.—Local information.

*Chief Facts reported by Inspector:* Extensive epidemic of enteric fever occurring suddenly and simultaneously in certain towns and villages situate in the valley of the River Tees. The only sanitary circumstance common to the invaded districts, water supply procured, through different waterworks, from practically one and the same point in the River Tees. Numerous sources of dangerous pollution of the Tees water observed above the intakes of these water works. The amount of pollution in the water immediately before the appearance of the epidemic had been increased to an exceptional extent in consequence of a heavy flood. (*See* p. 63 of present volume.)†

21. Tendring Rural Sanitary District (Essex); population (1881), 24,163; Mr. Spear.

*Sanitary Authority:* Tendring R.

*Ground of Inquiry:* Diphtheria at Lawford and other places in the neighbourhood of Manningtree; local complaint.

*Chief Facts reported by Inspector:* Widespread prevalence of sore throat and "follicular tonsilitis" followed in particular localities by definite diphtheria. The diphtheria spread by personal communication, particularly at school. Sanitary wants of country villages less fully considered and dealt with by the Authority than those of larger groups of population.

22. Wells (Norfolk); population (1881), 2,645; Mr. Spear.

*Sanitary Authority:* Wells U.

*Ground of Inquiry:* Need for further information as to sanitary state of the district, especially as to conditions of water supply.

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* Report reprinted as App. A. No. 10 of present volume.

† Report reprinted as App. A. No. 8 of present volume.

*Chief Facts reported by Inspector:* A closely-built old town having exceptionally narrow streets and numerous courts. Sewers, partly old brick culverts, partly socketed pipes, and unprovided with ventilation, have replaced cesspools. Meanwhile (watercloset not having been to any large extent adopted) privy pits replaced by professedly water-tight tank-privies of small dimensions. These receptacles scavenged by private contract. Water supply from numerous wells sunk 10 to 40 feet through the soil of the town, polluted for generations by leaky cesspools, privy pits, and drains. Samples from representative wells, on recent chemical analysis, all pronounced dangerous. (*See* p. 136 of present volume.)*

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* Report reprinted as App. A. No. 16 of present volume.

## No. 7.

### On the Sanitary Condition and Administration of the Rural Sanitary District of Staines, Middlesex; by Dr. Blaxall.

The Rural Sanitary District of Staines, covering an area of 23,484 acres, with an estimated population of 21,400 persons, is situated in the south-west corner of Middlesex, having on the north the Rural Sanitary District of Uxbridge; on the south the River Thames; on the east the Urban District of Heston and Isleworth, the Urban District of Twickenham, and the parish of Hampton in the Rural District of Kingston; and on the west the Rural District of Eton, the Urban District of Staines, and the River Thames.

The district comprises the 12 parishes of Ashford, Bedfont, Cranford, Feltham, Hanworth, Harlington, Harmondsworth, Laleham, Littleton, Shepperton, Stanwell, and Sunbury. The West London District School is situated in the parish of Ashford; and the Middlesex Industrial School in the parish of Feltham.

The subsoil of the district is gravel overlying London clay; the surface is rich loam. Brick-earth, which was once extensively present, has been largely used up, and the pits left by its removal are now generally used as water-cress beds. The country is very flat, having but a very gentle incline towards the river. The district has many ponds and is freely traversed by ditches, brooks, and streams, which all run directly or indirectly into the river. The gravel, too, is filled with water, which rises and falls with the Thames.

The people are mostly employed on the land, which is very highly cultivated, producing a considerable amount of fruit and vegetables for the London market. Building is going on to a great extent, the locality being attractive to residents on account of its near vicinity to London, and the facility of access by three lines of railway. Whole estates are being laid out for building purposes.

I made an exhaustive inspection of the district, visiting the several villages, hamlets, and blocks of new buildings, with the result of finding at every step of the inquiry unmistakeable evidence of the want of efficient sanitary administration.

The district contains many large villages and populous places which are unprovided with proper sewerage and drainage for the purposes of the Public Health Act. In such places, as a consequence, slop and waste water is thrown on to the surface to soak away as best it can, or is disposed of in cesspools, or sometimes in privy-pits sunk some feet deep.

*Cranford* is the only one of the villages provided with systematic sewerage and drainage, and this was done by the vestry before the guardians were constituted the Rural Sanitary Authority. Slop nuisances were far less frequent in Cranford than in other parts of the district, and where met with they were mainly on premises which had no drain connexion with the sewer. In Cranford the sewers are constructed of glazed pipes. The main sewer, conveying closet-contents and slop and waste water, is laid along the principal street, and, uniting with the Bath Road sewer, is carried under meadow land to settling tanks. These were originally two in number; the solids precipitated in them, and from them the effluent

sewage was conveyed to the Yedding brook, which discharges into the Thames. The Thames Conservancy took action against the Authority for thus polluting the brook, and obtained damages, and by way of remedy, two additional tanks were subsequently built; into these the effluent sewage is received after leaving the original tanks, and from the new tanks it passes into runners, and thence ultimately, by soakage, into the Yedding brook. I am told the sewers were ventilated by means of surface-openings, but that these proving offensive were covered over. Formerly the main sewer of Cranford was flushed with water derived from a pond, but this has been dried up some time, and no other means have been substituted.

With the intention of flushing the Bath Road sewer, provision is made for the delivery by meter of some 70 gallons of water per minute into the sewer. This quantity owing to the mode of delivery does not fill the bore of the sewer, and the arrangement appears, moreover, to be open to objection, as it contravenes the elementary rule that there should be no direct communication between water mains and sewers. A very much more efficient flushing could be obtained, while all risks incidental to this connexion would be got rid of, if a tank were interposed between the water mains and the sewer and were so arranged as to discharge at intervals a volume of water sufficient to fill the sewer and to wash the whole of its interior.

At *Harmondsworth* a "double-barrel" brick sewer was laid by the vestry from a ditch at the upper end of the village to another ditch in a lane at the lower end, where the contents empty into a tank for the settling of the solids, the effluent sewage passing along the ditch to the river. This sewer mainly carries surface water, but in its course receives the contents of a few house drains. At *Feltham* an old highway sewer, intended originally for the conveyance of surface water to a pond situated near the centre of the village, now receives the contents of certain house drains, thereby polluting the pond and giving rise to offensive nuisances. At *Sipson* the Authority have recently converted a series of catchpits into a so-called sewer, by means of glazed pipes laid from pit to pit to carry the overflow from one to the other, till finally the sewage passes into an open ditch. This continues alongside the high road, and is complained of as a nuisance by the inhabitants of neighbouring dwellings. The first of the catch-pits receives the drainage of several cottages and is situated within a few feet of the end cottage, the occupants of which complain of the intolerable stench from it. Indeed, they have reason, for the contents of the catchpit amounted at the time of my visit to some four feet of black stinking mud. And from this point onwards, this series of stinking pits gives rise to nuisance. They are called "sewers," but offend against every principle of sewer construction.

As regards the communications of house drains with cesspools, I am able to report that attention has been given to this matter by the Sanitary Authority, and that in many instances the house drains are duly "disconnected" from the cesspools. There are, however, many houses where the drain-pipe discharges direct into a cesspool, and serves as a channel for the delivery of foul air into the dwelling-rooms.

The Authority have been content to allow the old cesspit privies to continue in general use regardless of the attendant evils of filth-pollution of earth, air, and water. Some few cesspits are shallow and open, but they are mostly covered in and sunk some feet into the soil. This

allows, and no doubt is intended to allow, of long storage of excrement and of the oozing away of the fluid contents of cesspits. This soakage into the gravel takes place readily when the sub-soil water is low, but as the water rises the cesspits are apt to refill so as sometimes to overflow at the drain inlets; this is especially the case where slop drains communicate with the privy pit. A few examples came under notice of privy pits overflowing direct into neighbouring streams.

So I met with examples of every kind and every degree of cesspit nuisances, up to cases where people were living in houses with walls saturated with privy filth and with the rooms stinking with privy effluvia; the people suffering from nausea, sore throats, and the like. In a few instances pail-closets are in use, and although not properly kept they were a marked improvement upon the cesspit privies generally in vogue in the district.

The water supply of the Staines Rural District is mainly derived from wells sunk in the sub-soil, from which it is raised by pumps or buckets or through the so-called Abyssinian tubes. Now seeing that cesspools, privy pits, and wells are sunk in the common gravel within a few feet or yards of each other, and that the liquids in them rise and fall with the water in the sub-soil, there can be no doubt about what it is that the inhabitants have to consume under the name of water; and the fact of habitual pollution of water in these wells is evidenced by the frequent complaints made by the inhabitants adout their water, and by the reports of the medical officers of health. Mr. Lundy, in his annual reports for the years 1884 and 1885, directed special attention to the unwholesome character of the well water. In 1885 he stated that he had analysed 154 samples of water with the result of finding that "in several cases "the water was so impure as to be unfit for drinking or domestic "purposes." Each succeeding annual report referred to a number of new wells sunk in the place of polluted wells, or reported polluted wells as having been "cleaned out." Mr. Willoughby, the present medical officer of health, states in his report for 1889 that out of 39 samples of water examined by him he found 22 polluted.

The water-mains of three or four different water companies pass through this district, and afford to certain of the villages and dwellings the opportunity of obtaining water from external sources. This opportunity is gradually being made use of, certainly to the advantage of the district.*

At certain places, especially Stanwell, the people are dependent upon ditches and brooks for their supply. Such sources cannot fail to be exposed to pollution by people living along the banks, road-washings, fouling by ducks and cattle, drainage from farmyards, and the like. Consumers of water from these sources have been found to suffer greatly from worms.

Accumulations of refuse and manure are plentiful in the near vicinity of dwellings.

There are no byelaws for the regulation of slaughter-houses, the keeping of pigs, or for the construction of new dwellings. Such byelaws are greatly needed, and could at once be made if the Sanitary Authority had applied for and obtained (section 276, Public Health Act, 1875) the powers of an urban authority. At one place slaughtering was going on in an old barn, the wooden flooring of which was saturated

* I ought to mention a direct communication between water-mains and the closets of certain cottages at the rear of the "Royal Buck" inn at Cranford. It was such as appeared to me to endanger the water-supply of the South-western Suburban Company.

with blood, and there was a large accumulation of animal matter and manure outside. At another place an old stable with a brick floor had been converted into a slaughter-house, the blood from which was seen running into a ditch by the roadside.

In the new houses that are being constructed in the Staines Rural District, there is a lamentable neglect of elementary sanitary principles; and neglect in this matter is the more to be regretted, because these faults of construction must needs be so difficult to amend hereafter. Considerable areas have been laid out for building purposes, and a large number of new dwellings have actually been erected, in some places forming continuous streets. But no provision is made to secure these dwellings from dampness, nor for the efficient sewerage and drainage of the streets and houses, nor for a wholesome method of excrement removal, nor yet for the supply of wholesome water to the houses. In short, the new houses are being provided with the same sanitary faults as those that are found in the older houses of the district.

In 1888 the Authority adopted regulations for dairies and cowsheds. These establishments are registered, but it is clear that the duties imposed by the regulations are not efficiently carried out. . . . . The register is simply a copy of the old police register with additions as to fresh dairies. It contains no information as to the number of cows kept at the several dairies. It records nothing about the conditions under which cows are kept, nor as to the source of water used for dairy purposes or the like, nor does it give any information respecting the distribution of milk from the dairies.

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The general filthiness of soil and water in the Staines Rural Sanitary District is probably a matter of more than local concern. Besides the rain that falls on the district, large volumes of water course through the river gravel which forms the subsoil, and into this gravel are washed the contents of several thousand cesspools purposely dug in the gravel for convenience of discharge thereinto. The water thus befouled flows directly or indirectly into the Thames. Entering the Thames at various parts of the ten miles where the district abuts on the river, the principal and most direct flow of the water through the gravel bed of this district would seem to be from west to east, and its discharge to be mainly into the lower portion of the boundary river, in the neighbourhood of Sunbury. At a short distance below this neighbourhood, on the southern bank of the river, are situated the pumping stations of certain great London water companies. I shall not attempt to measure the amount of the actual impurity furnished by Staines Rural District to the Thames above these water intakes, nor shall I discuss the extent of depuration that may go on before the filth of the district reaches the river.* But I may at least direct attention to the prevalence in the Staines Rural District of that particular disease that disseminates itself especially by means of water.

In no one of the past seven years for which I have record has this district been free from typhoid fever. This disease has indeed been very high in rank among the "zymotic" causes of death. It is recorded as being the cause of 49 deaths during the seven years, and this number of deaths may be taken as indicating at least 500 cases of typhoid fever. We know of this disease that it is derived, habitually if not always, from antecedent cases of the disease, by means of excremental discharges from

* I find that attention is specially directed to this pollution of water in the gravel beds of the Thames, at Staines and in Staines Rural District, by General Scott, the Official Water Examiner, in his Reports for May 1887 and September 1888.

the sick; and that water contaminated by very small quantites of these discharges, so small as to escape recognition by chemical tests, can produce fresh attacks of the fever. For example, in 1885, typhoid fever obtained extravagant proportions in the Staines Rural District, especially at the West London District School, and no less than 24 deaths from this cause took place. The spread of the disease was, no doubt, justly ascribed to the drinking of "specifically contaminated" water. But the discharges from each several case of typhoid fever in the Staines Rural District, if they find their way from the district cesspools along the gravel stream into the Thames, have the opportunity of "specifically contaminating" vast quantities of the river water; so that nothing but the efficiency of the water company's filtration stands between the typhoid matter entering the river at Sunbury and the consumption of that typhoid matter by the water drinkers of half London.

What is true of typhoid fever in this connexion is beyond doubt true for Asiatic cholera, so that cases of this cholera in the Staines Rural District might have disastrous results for the metropolis.

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I propose to devote the remainder of this report to an account of the infectious diseases which have been present in the Staines Rural Sanitary District during the past seven years. And I shall not hesitate to tell this story at some length, since the extent of prevalence in this district of disease that largely can be prevented by public and private measures of isolation, the ignorance of the people about such measures of prevention, and the vacillation and incompetence of local administration in this matter, deserve to be shown.

Instead of taking the sick from the houses in which infectious disease has broken out, and placing them in a hospital where they would get sanitary advantage combined with medical treatment, the plan of the Sanitary Authority has been to allow the infected sick to remain in homes where isolation was impossible, and on occasion to send a nurse to attend upon them; with the result of adding to the already crowded state of the infected dwelling. The Authority possess no efficient means for the disinfection of the infected clothing, bedding, &c. Up to the time of my inquiry they had not made arrangements with the local registrars to supply the medical officer of health with weekly returns of mortality; nor had they caused him to be informed of the occurrence of infectious sickness amongst paupers.

Formerly the Authority took a more enlightened view as to the action necessary to arrest the progress of infectious disease, and in the year 1881, recognising the necessity of making infectious hospital provision, the Sanitary Authority of that time came to the conclusion that this could best be done in unison with the Staines Urban Sanitary Authority; accordingly, with the concurrence of the Urban Authority, application was made to the Local Government Board to amalgamate the two districts for the purpose, and to constitute a joint hospital board. In the following year, after inquiry held by the Board's Inspectors, Mr. Henley and Dr. Parsons, the proposal for a joint board received the assent of the Department, and a joint board was formed consisting of six members of Staines Rural Authority and three members of Staines Urban Authority. This body entered into an agreement with the Staines Board of Guardians to hire from them two acres of ground as a site for the proposed hospital; and in May 1883 the joint board applied to the Local Government Board to sanction a loan of 4,500*l.* to enable them to build the hospital. Inquiry having been held by Mr. Codrington,

C.E., and Dr. Barry, the loan was sanctioned and the building forthwith begun.

In the spring of 1884 it would seem that some hostility to the hospital scheme had sprung up, and the election of the Guardians of the Poor resulted in the return of a majority of representatives opposed to making hospital provision. The ratepayers of the Staines Union must be held responsible for what ensued. The Guardians chose to rescind the resolution of their predecessors letting their land to the joint board, while in their capacity as a Sanitary Authority, and having a predominating influence in the joint board, they took no other means for obtaining another hospital site. The Guardians gave notice to the builders not to trespass upon the plot of land. So a stop was effectually put to the building operations, and the two sanitary districts, urban and rural, have remained without an isolation hospital. From that time to the present the matter has been at a deadlock. No payment has been made to the builders, and the building, which was considerably advanced, has gradually deteriorated through exposure to weather.

It is scarcely within the province of this report to follow the question through its various phases which formed the subject of correspondence with the Board, or to consider the proposition to convert the building into infectious wards for pauper sick, or the memorial of ratepayers setting forth the sanitary need for a hospital for the use of infective patients of all ranks where the circumstances of their lodgment in their own homes forbade their due separation from healthy inmates. But, given the history of infectious disease in Staines Rural District, any reader of this report can judge for himself as to the want of an isolation hospital there.

I have examined the mortality statistics of the district together with the Reports of the Medical Officer of Health and Inspector of Nuisances for the last seven years, 1884–1890, with the result of finding that a notable amount of infectious sickness of one kind or another has been present each year.

The following table, extracted from the official returns made by the Medical Officer of Health, shows the amount of mortality from certain given diseases during the seven years, 1884–1890:—

| Year. | Small-pox. | Measles. | Scarlatina. | Diphtheria | Croup. | Typhoid Fever. |
|---|---|---|---|---|---|---|
| 1884 | 3 | 1 | 4 | 2 | 1 | 3 |
| 1885 | — | 16 | 3 | — | 3 | 29 |
| 1886 | 4 | 6 | — | 1 | — | 2 |
| 1887 | — | 7 | — | 6 | 1 | 9 |
| 1888 | — | 4 | 1 | 5 | 2 | 1 |
| 1889 | — | — | 1 | 3 | 1 | 2 |
| 1890 | — | 31 | — | 5 | — | 3 |
| Total | 7 | 65 | 9 | 22 | 8 | 49 |

The following general considerations should be held in view in my account of the above-named diseases. Every day experience shows that scarlatina and diphtheria introduced into the houses of people of the artizan and labouring class cannot be limited to the first sufferer if he have to be treated at home. Prompt isolation in hospital of the early cases of these diseases is therefore an essential means of preventing their spread. Small-pox, one of the most contagious and dangerous of diseases, is comparatively easy of control by reason of the prophylactic

of vaccination and re-vaccination, with prompt isolation of the early cases should the disease appear. I have been unable to learn what measures of vaccination were taken in 1884–6 for the repression of small-pox, and shall have to state the facts that are on record about other attempted methods of dealing with the disease. Measles, on account of the tender age at which it attacks children, and the long incubating period of the disease (10 to 14 days) offers difficulties in the way of removal of the cases to hospital, but such means of isolation may at times be carried out with great advantage. Typhoid fever, lastly, requires in an eminent degree the removal of the sick from infected houses, with a view to the cleansing of such houses, the purification of them from all excremental matters, and the rigorous disinfection of discharges from the sick that may endanger air and water.

The foregoing statistics of mortality give but little information as to the extent to which cases of infectious disease have prevailed in the Staines Rural District; so I proceed to supplement the mortality records by such details about prevalent epidemics of sickness as I have been able to glean from the reports of the successive medical officers of health and the inspectors of nuisances. These officers submit fortnightly reports to the Authority, some of which I had the opportunity of examining together with their annual reports.

Mr. Lundy was Medical Officer of Health for the years 1884, 1885, and part of 1886, and was succeeded by Mr. Willoughby, the present officer, in 1887.

1884.—The reports for this year contain mention of the presence of infectious disease (chiefly small-pox and scarlatina) throughout the year, save in the month of May.

*Small-pox* appears first in Mr. Lundy's Report of February 29th. It had occurred at Sunbury in a lad from London; his father and mother were next attacked and the father died. From this dwelling the disease spread to another family in Sunbury and affected one person only. After an interval of some weeks a somewhat simultaneous outbreak in three different villages is reported, viz,, one case each at Bedfont, Harmondsworth, and Ashford, on June 13th, 15th, and 16th respectively, with a second family invaded at Bedfont on the 19th June. No history is given of the origin of the cases on the 13th, 16th, and 19th of June, but the case of the 15th is said to have been in an unvaccinated child from London, who manifested small-pox a few days after arrival at Harmondsworth. This case was fatal. Subsequently other houses in this and the adjoining villages were invaded. In all, so far as my information goes, 18 families were infected with small-pox during the year. In six of these, multiple cases occurred, four in one house, three in each of four houses, and two in the remaining house, with a total of three deaths. One of these was a poor woman who contracted the disease soon after child-birth from an infected member of the family, and died leaving five children who were taken to the workhouse, where three of them still remain. Mr. Lundy records carrying out vaccination and re-vaccination where he could, and would appear to have adopted every means of isolation that lay in his power to prevent the spread of the disease, but without avail. At one place the occupants of five cottages adjoining an infected dwelling were induced to remove to another locality. Nurses were supplied to five of the infected families at a cost of some 38*l.* Provisions were supplied to three families at a cost of 27*l.*

During the same year *scarlatina* is reported as being present at Ashford, Bedfont, Feltham, Harlington, Hanworth, Hatton, Laleham, Sipson, and Sunbury, continuing at Feltham and Sunbury from September to December, multiple cases occurring in certain houses.

1885.—Small-pox was again present, invading four dwellings, besides two other cases, one in a tramp who was received into the workhouse, and the other a case that occurred in a gipsy caravan. There is no information as to the origin of the first case. This is mentioned by the Inspector of Nuisances in his report of the 28th April. The second case is given by Mr. Lundy in his report of May 13th, as occurring in a servant who returned from Hounslow to her home at Feltham while suffering with the disease. Her father kept a greengrocery shop, which Mr. Lundy states he "deemed advisable to have closed," and he also thought it right "to direct the man to stop at home." A nurse was put in charge of the invalid. Two fresh houses were invaded in June, one at Stanwell, the other at Harmondsworth, but whether related to the previous case there is no evidence to show. The infected gipsy caravan was located in a field removed from the road, where it is needless to say it did not long remain, but started off on its peregrinations to spread disease among the susceptible people of neighbouring districts.

*Measles* was very prevalent throughout the district, especially at Feltham, causing 16 deaths.

*Scarlatina* was present at Ashford, Sunbury, Feltham, Shepperton, Hanwell, and Littleton. The sequence of cases as reported at Ashford and Sunbury is such as to suggest the probability that the spread of the disease was due to personal intercommunication between infected and healthy. Multiple cases occurred in certain families, amounting to five in one dwelling, the disease in this instance continuing present from May to August. Nurses were supplied to six infected families at a cost of 25*l.* and upwards; and provisions to one family to the amount of 6*l.*

*Typhoid Fever.*—Of the 29 deaths referred to this disease 24 occurred in the West London District School, where (as already recorded) the outbreak was ascribed to the drinking of specifically contaminated water. No information is given respecting the remaining five deaths, which would represent some 50 cases; they were probably scattered about the district.

1886.—This year opened with a smart epidemic of *small-pox* at Feltham prevailing from January to May, and invading twelve dwellings with 22 cases and three deaths. From two to four cases occurred in seven dwellings. The disease was introduced into Feltham by a young man who lodged at No. 3, Railway Place, and is said to have contracted it in London. This house was a small provision shop. The family, consisting of husband, wife, and three children, occupied a small bedroom measuring only 847 cubic feet. The lodger slept in the adjoining room, 630 cubic feet. Mr. Lundy observes that "isolation is impossible," that the woman was expecting her confinement, and if it should come on "he did not know what he should do"; that he had tried to get the adjoining cottage, but the occupants would not turn out. He advised that the shop should be closed, and the man should keep away from his daily work, and he *sent a nurse* to look after the infected lodger, who presently died. The shopkeeper, his wife, and two of the children contracted the disease and continued to occupy their one small bedroom. On the 16th February Mr. Lundy reports an extension of

the disease mainly confined to Railway Place and that neighbourhood, and he attributes the spread to personal intercommunication between the infected and their friends and neighbours. He remarks, "We have "now reached a total of 17 cases, and the disease seems as if it would "spread further, as I have two other suspicious cases under observa- "tion." He adds that he had been looking about for some cottages suitable for isolation purposes with a view to recommending the Authority to hire them. He goes on to say that he had failed to find any such cottages, and he proceeds to advise the Authority to make arrangements with the Heston Local Board to receive any fresh cases that might occur into their hospital, adding, "It is quite impossible to "keep relatives from going to the houses so long as the infected "persons remain in their own homes." A resident of Stanwell who was employed to assist in placing the body of the above-mentioned lodger into his coffin contracted small-pox and communicated the infection to his wife. The disease also spread to Bedfont, where four or five cases occurred in one house. In two instances during this outbreak, the sanitary officers were driven to find some means of lodgment for small-pox cases. In one a father refused to allow his infected son to remain at home to the danger, as he said, of the rest of the household. An order was therefore obtained for his admission to the iron building at the workhouse originally provided for isolating an infected tramp. The other instance was that of a young man, who, having contracted the disease through visiting the first infected house at Railway Place, was not allowed to return to his lodging; to meet this case a cottage in Railway Place was hired for his reception. Nurses were sent to several infected houses at a cost of 51*l.* 5*s.* The provisions supplied, 60*l.*, and compensation made for the destruction of infected clothing, 47*l.*

The epidemic at Feltham caused much apprehension and alarm among the residents, resulting in their sending a numerously signed memorial to the Local Government Board praying that steps might be taken to secure the provision of proper means of isolation for cases of infectious disease.

*Scarlatina* was present at Ashford, Feltham, Hanwell, Shepperton, and Sunbury during the year, and we have seen by the table that deaths occurred from *measles*, *diphtheria*, *and typhoid fever.*

1887.—Mr. Willoughby, medical officer of health, reports the prevalence of *measles* throughout the year, chiefly in the parish of Ashford, causing seven deaths, and he ascribes the "mortality to the pneumonic affections so common to the disease." *Scarlatina* is reported in the parishes of Ashford, Sunbury, Feltham, Shepperton, and Stanwell in a mild form and unattended with mortality. A nurse was sent to one of the infected families, where five cases occurred, at a cost of 9*l.*, and provisions to the amount of 24*l.* The family consisted of a man, his wife, and five children. The man and his eldest son were away harvesting at the time of the outbreak. One of the little boys was first attacked, then his mother, followed by three other children, including the eldest son, who returned from harvesting to this infected dwelling. The man did not sleep at home after his return.* The accommodation consists of two rooms opening one into the other, measuring respec-

* During my inquiry I visited this house and found a little girl just attacked with measles sitting on the bed where her brother was lying with a broken leg.

tively 752 cubic feet and 690 cubic feet. With regard to other diseases of the year, three houses are reported as having been disinfected after diphtheria and three others after typhoid fever. But, as shown by the mortality table, diphtheria caused six deaths and typhoid fever nine, and about the non-fatal cases I learn nothing, though the nine deaths from typhoid may be taken to represent some 90 cases of illness.

1888.—Two cases of *small-pox* were reported this year. *Measles* prevailed extensively at Feltham, causing four deaths. *Scarlatina* appeared at Shepperton in January and February, Stanwell in March, Harlington in March and April. These cases were probably related to the scarlatina of the preceding year. The disease appeared again in an epidemic form in October in the hamlet of Hatton, close to Harlington, and in the village of Bedfont. Mr. Willoughby when seeking out the origin of this outbreak found reason to connect it with cases that had been appearing in Harlington Lane, but which had been of so mild a type as to have escaped observation. Perhaps the disease had continued in Harlington from April to October. *Diphtheria* again caused notable mortality (five deaths), and *croup* two deaths. Nurses were sent to some infected families at a cost of 7*l*., and provisions cost 38*l*.

1889.—Again we have to notice the occurrence of *scarlatina* at Ashford, Laleham, Feltham, Harmondsworth, and Sunbury, where it prevailed in an epidemic form from September to December, when it was so prevalent that Mr. Willoughby deemed it advisable to recommend the closing of the schools. As the death table shows, there were three deaths from *diphtheria*, one from *croup*, and two from *typhoid fever*. Nurses were sent to seven families at a cost of 15*l*.

1890.—*Measles* prevailed very generally, and the schools were closed in consequence at several of the villages. The mortality was large, amounting to 31 deaths. *Scarlatina* again manifested itself in several parishes, notably at Hanworth and Sunbury. The mortality from *diphtheria* was again high, causing five deaths, and there were two deaths from *typhoid fever*.

The striking mortality from measles during these recent years, as shown on the mortality table, contrasts remarkably with the mortality from scarlatina; there were 65 deaths from measles to nine deaths from scarlatina, although scarlatina has prevailed extensively year by year and at times in epidemic proportions. This subject is well worthy the attentive consideration of the Medical Officer of Health as regards the ratio of deaths to attacks in measles, and the incidence of measles in its fatal form upon particular houses or localities. For it has elsewhere been noticed, in districts showing a marked excess of mortality from measles compared with scarlatina, that the mortality ascribed to measles results, in a very unusual degree, from superadded disease of the respiratory organs; and that the supervention of this complication has been due to dampness of dwelling-houses. I observe that Mr. Willoughby at Ashford records the fact of these complications being frequent in measles; and he might profitably extend his inquiry to the local distribution of respiratory diseases (pneumonia, bronchitis, and the like, particularly among children) in his district, beyond the cases of such disease as are related to measles.

I have said that I should leave the readers of my report to draw, from the recorded experiences of this district, their own conclusions as to the need for public isolation provision. But it may be just to the Local Sanitary Authority to point out—in this dismal account of disease

spread by ignorant gossips, of fevers prostrating whole households, of infected vagrants let go their ways, of the sick turned into the streets for fear of infection—that the omission to provide an isolation hospital has apparently not been dictated by considerations of economy; as the Sanitary Authority* have frequently sent nurses to attend on the sick at their own homes. It is true that the nurse may sometimes have done as much harm as good, in that she has added another inmate to the already stinted bedroom accommodation of an infected cottage; but at any rate the cost of the nursing has been defrayed, legally or illegally, by the Sanitary Authority; and at an expense of 189*l.*, apart from the expense of provisions and of compensation for destroyed clothing. But while the Authority may be credited with such generosity in their care for the sick, it is not the less clear that their procedure has failed to attain the proper object of a Sanitary Authority, to prevent the spread of infection in the district.

I examined the building that had been begun to serve as an isolation hospital, and which had subsequently been taken to themselves by the Guardians and had been let go to ruin. It is situated in a central and convenient locality, a mile or two distant from Staines Urban District and from five or six villages of the rural district; and not more than four or five miles from the more remote villages of the rural district. The design of having such a hospital to serve jointly for the urban and the rural districts appeared to me altogether commendable; and the only objection that was raised, in my hearing, to the scheme was, that the site of the building was too near to the Staines Union Workhouse. But this objection must have been considered and disposed of before building operations were begun. It is to be noted that the site has a separate approach of its own independent of the workhouse, and that the hospital administration would be totally distinct; and given a well-managed hospital, sentimental objection on the score of this proximity would have vanished before the past ten years had elapsed; while, if the aspect of the workhouse had been repulsive to the hospital inmates, an interposed shrubbery would by this time have grown into an effectual screen. I do not suppose, however, that I have penetrated the actual reasons that led to the abandonment of the hospital scheme; and can only guess that some short-sighted parsimony, with some inexplicable local hostilities, has brought about the deplorable result.

I have little to record about the officers of the Sanitary Authority. The Inspector of Nuisances knows his district well, and each year reports a couple of hundred, more or less, of nuisances, a large number of them being recurring nuisances, such as to show—if further evidence were wanted—that the measures taken for the improvement of the district are not based on any comprehensive notion of its sanitary requirements. The Medical Officer of Health, too, does his work according to his lights, attending to matters that are immediately urgent, and making a report to the Authority every fortnight. But he seems to have little sense of the radical defects that operate to the injury of health throughout his district, and has made no attempts in his reports to deal with them in a systematic matter. His annual reports have been so

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* The Sanitary Authority have also undertaken some processes of disinfection at infected houses; and have issued printed notices setting forth the penalties attaching to those who expose infected persons and things. They have given warnings also about the danger of spreading scarlatina by attendance at schools and churches of persons going from infected dwellings.

barren as to call for special animadversion on the part of the Local Government Board. The want of system and thoroughness on the part of the officers is matter of blame rather to the Sanitary Authority than to themselves. The Authority appear to be content with their own administration, and to have no particular anxiety beyond such superficial matters as are forced upon their immediate notice. It does not seem that they have ever invited the Medical Officer of Health to their counsels or have ever requested his presence at any meeting.

## No. 8.

### Interim Report on an Epidemic prevalence of Enteric Fever in several towns situate in the Valley of the River Tees in South Durham and North Yorkshire; by Dr. Barry. (January 1891.)

In September 1890, when at Middlesbrough on official business, it came to my knowledge that enteric fever was exceptionally prevalent in Middlesbrough, North Ormesby, and Stockton-on-Tees. At the same time it was rumoured that there was a similar prevalence in other neighbouring towns. I immediately communicated with the medical officers of health for those towns, and ascertained that an unusual number of cases of enteric fever had been notified during the earlier weeks of September to the health departments of the South Stockton, Darlington, Eston, and Ormesby urban sanitary districts, the areas invaded being all comprised within the Registration Districts of Darlington, Stockton, and Middlesbrough. Upon reporting this information to the Board, I was at once directed to make inquiry into the matter, and to confer with the local authorities and their officers as to the precautions to be taken in reference to the outbreaks.

This inquiry, which fully occupied me during several weeks of October and November, is not, as regards certain matters of detail, yet complete. Under the circumstances it has been considered desirable that a summary of the broad facts already observed should, for the information and guidance of the sanitary authorities concerned, be briefly recorded in an interim report, reserving the detailed consideration of a number of complex facts to be dealt with in a future report. In the following interim report, therefore, I propose, after giving a short account of the method of inquiry, to deal with the earlier weeks of the epidemic only, a period in which the study of its etiology was practically uncomplicated by the occurrence of local extensions of fever in sequence to the epidemic outburst. It must also be premised that the figures quoted are approximate, and may possibly be subjected to some minor corrections when further detailed material has been obtained.

In order to ascertain (*a*) the extent and (*b*) the limitations of the epidemic prevalence, I, in the first instance, obtained from the medical officers of health of the several sanitary districts, situate not only in the Registration Districts already invaded, but also in the Registration Districts immediately adjacent to those invaded, returns showing the number of cases of enteric fever which had from day to day come to the knowledge of the respective health officers during the period 1st January to October 4th, 1890.

These Registration Districts are 10 in number, and comprise within their boundaries 32 sanitary districts situate to the north and south of the river Tees in the counties of Durham and Yorkshire respectively. In the following Table I. is given a list of these 10 Registration Districts and of the sanitary districts comprised within them, together with the acres, inhabited houses, and population of each district as recorded

in the census of 1881. In the last column of the table the number of dwelling-houses which were ascertained to be on the rate books of the several districts in December 1890 is also given.

## Table I.

Showing the Acres, Inhabited Houses, and Populations of the several Sanitary Districts comprised within the Area of Inquiry as ascertained at the Census of 1881, together with, in each instance, the Number of Houses on the Rate Books of the Sanitary Authorities at the end of 1890.

| Registration Districts. | Sanitary Districts. | Area in Acres. | Inhabited Houses, Census 1881. | Population, Census 1881. | Houses on Rate Books, 1890. |
|---|---|---|---|---|---|
| 1. | 2. | 3. | 4. | 5. | 6. |
| Teesdale - - | Teesdale Rural - - | 177,714 | 3,319 | 16,233 | 3,602 |
| | Barnard Castle Urban - | 632 | 936 | 4,544 | 1,018 |
| Auckland - - | Auckland Rural - - | 62,259 | 11,521 | 58,854 | 12,455 |
| | Bishop Auckland Urban - | 950 | 1,837 | 10,097 | 2,126 |
| | Shildon Urban - - | 1,066 | 1,762 | 8,704 | 2,012 |
| | Spennymoor Urban - | 176 | 1,140 | 5,917 | 1,133 |
| Darlington - - | Darlington Urban - | 3,910 | 6,480 | 35,104 | 7,842 |
| | Darlington Rural - - | 61,795 | 2,547 | 12,572 | 2,562 |
| Stockton-on-Tees - | Stockton-on-Tees Urban - | 1,189 | 7,383 | 41,015 | 9,118 |
| | Stockton Rural - - | 35,898 | 1,962 | 10,137 | 2,077 |
| | Sedgefield Rural - - | 45,307 | 3,143 | 17,103 | 3,066 |
| Hartlepool - - | Hartlepool Urban - | 546 | 2,657 | 15,803 | 2,657* |
| | West Hartlepool Urban - | 2,510 | 5,252 | 29,448 | 7,714 |
| | Hartlepool Rural - - | 18,180 | 391 | 2,167 | 443 |
| Northallerton - | Northallerton Urban - | 3,650 | 761 | 3,692 | 832 |
| | Northallerton Rural - | 63,350 | 1,790 | 8,192 | 1,893 |
| Stokesley - - | Stokesley Rural - - | 79,708 | 2,582 | 12,009 | 2,593 |
| Middlesbrough - | Middlesbrough Urban - | 2,731 | 10,391 | 55,934 | 13,712† |
| | South Stockton Urban - | 1,052 | 1,934 | 10,665 | 2,738† |
| | Ormesby Urban - - | 2,836 | 1,473 | 7,719 | 1,576 |
| | Normanby Urban - - | 1,413 | 1,299 | 7,714 | 1,688 |
| | Eston Urban - - | 2,252 | 1,090 | 6,297 | 1,934 |
| | Middlesbrough Rural - | 12,107 | 305 | 1,581 | 336 |
| Guisborough - - | Kirkleatham Urban - | 4,330 | 722 | 3,898 | 902 |
| | Redcar Urban - - | 900 | 500 | 2,458 | 727 |
| | Guisborough Urban - | 7,014 | 1,261 | 6,616 | 1,447 |
| | Skelton and Brotton Urban | 15,536 | 2,569 | 13,558 | 3,013 |
| | Saltburn-by-the-Sea Urban | 600 | 298 | 1,646 | 481 |
| | Loftus Urban - - | 2,550 | 1,315 | 6,699 | 1,599 |
| | Guisborough Rural - | 52,758 | 1,612 | 8,251 | 1,510 |
| Richmond - - | Richmond Urban - - | 2,520 | 860 | 4,502 | 927 |
| | Richmond Rural - - | 78,581 | 1,854 | 8,956 | 1,919 |
| Totals - 10 | 32 | 746,020 | 82,946 | 438,085 | 97,452 |

* Return of houses for 1890 not received.

† These figures were furnished by Mr. D. D. Wilson, the general manager of the Stockton and Middlesbrough Waterworks.

Taking the whole area of inquiry, it will be seen from the above table that the district contained in 1881 nearly 83,000 inhabited houses, and a population of over 438,000 persons, and that in 1890 the number

of inhabited houses had risen to upwards of 97,000, which would accommodate nearly 520,000 persons, assuming that the population per house which had obtained in 1881 had been maintained. In the sketch map accompanying this report the relative geographical position of the districts is shown, and it will be seen that the area of inquiry practically embraced the whole valley of the River Tees from its source to the sea, and, in addition, areas lying immediately to the north and south of this valley.

From returns obtained from official and other sources, it became apparent (*a*) that although the number of cases of enteric fever reported had been above the average in certain districts during the earlier months of the year, they had been generally below the average during the four months May, June, July, and August; (*b*) that in certain districts a sudden and large increase in the number of cases of enteric fever had taken place during the fortnight ending September 20th, and that these exceptional amounts of fever had been fully maintained during the succeeding fortnight ending October 4th; and (*c*), that whilst the increase in the number of cases was general and fairly uniform throughout some of the districts invaded, in others it was confined to portions of them only. In Table II. (see pp. 66–8) a summary of the returns received from the medical officers of health and other medical men is given, showing the number of cases fortnight by fortnight in the respective districts during the period January 1st to October 4th, 1890.

From the following table it will be seen that during the four weeks ended October 4th, over 570 cases of enteric fever were reported to have occurred throughout the whole Area of Inquiry, and from a detailed examination of the returns, I ascertained that these cases had occurred in some 550 houses.

As it is now nearly 10 years since the date of the last census, the accuracy of any estimate of the population based on data so remote would be problematical. On the other hand, the number of houses obtained from the rate books may be regarded as fairly accurate, and consequently, in discussing the incidence of the fever, I propose to deal always with the number of houses invaded per 1,000 total houses instead of taking attack rates on population. Taking the present number of houses in the whole district as 97,000, the number of houses invaded (550) in the four weeks in question is equivalent to a house attack rate of not quite 6 per 1,000.

Upon consideration of the facts for the separate Registration Districts, considerable differences in the house attack rates were observed. The house invasions per 1,000 houses for the separate Registration Districts during the four weeks ending October 4th having beer approximately as follows:—Teesdale, under 5; Auckland, slightly over 1; Darlington, 11; Stockton, 10; Hartlepool, 1; Northallerton, nil; Stokesley, under 1; Middlesbrough, 12·5; Guisborough, 1; and Richmond, nil. In the Registration Districts the house attack rates were thus above the average in three districts only, namely, Stockton, Darlington, and Middlesbrough.

## TABLE II.

Summary of Returns* received from Medical Officers of Health and private Medical Practitioners showing Number of Cases of Enteric Fever fortnight by fortnight in each Sanitary and Registration District comprised within the area of the Tees Inquiry, during the period January 1st to October 4th, 1890.

| Registration District. | Sanitary District. | Cases of Enteric Fever reported to the Medical Officer of Health during the Fortnight ending | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Jan. 11. | Jan. 25. | Feb. 8. | Feb. 22. | Mar. 8. | Mar. 22. | April 5. | April 19. | May 3. | May 17. | May 31. | June 14. | June 28. | July 12. | July 26. | Aug. 9. | Aug. 23. | Sept. 6. | Sept. 20. | Oct. 4. |
| 1. | 2. | 3. | 4. | 5. | 6. | 7. | 8. | 9. | 10. | 11. | 12. | 13. | 14. | 15. | 16. | 17. | 18. | 19. | 20. | 21. | 22. |
| Teesdale | Teesdale Rural* | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | 1 |
| | Barnard Castle Urban | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | 1 | 1 | — |
| | | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | 1 | 1 | 1 |
| Auckland | Auckland Rural* | 1 | 1 | 1 | 3 | — | 1 | — | — | — | 1 | — | 1 | 1 | — | 3 | 1 | 1 | — | 2 | 17 |
| | Bishop Auckland Urban* | 2 | — | 1 | — | — | — | — | — | — | 1 | — | — | — | 1 | — | — | — | — | — | 4 |
| | Shildon Urban* | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | 1 | — | 1 |
| | Spennymoor Urban | 3 | 1 | 5 | 1 | — | 2 | — | — | 1 | 2 | — | — | — | — | — | — | 1 | — | — | 1 |
| | | 6 | 2 | 7 | 4 | — | 3 | — | — | 1 | 4 | — | 1 | 1 | 1 | 3 | 1 | 2 | 1 | 2 | 23 |
| Darlington | Darlington Urban | 1 | 4 | 1 | 7 | 4 | 2 | 1 | 2 | — | 4 | 3 | — | — | 2 | — | — | — | 3 | 55 | 46 |
| | Darlington Rural | 2 | — | — | — | — | — | — | 1 | — | — | — | — | — | — | 1 | — | 1 | — | 6 | 8 |
| | | 3 | 4 | 1 | 7 | 4 | 2 | 1 | 3 | — | 4 | 3 | — | — | 2 | 1 | — | 1 | 3 | 61 | 54 |

* A number of the returns in question were based on data supplied to the Health Officer under the Notification Act or Acts. In certain districts, marked always in the table by an asterisk, "Notification" not being in force, the returns in question are based on such data as had been obtained by the Medical Officers of Health, and also on information supplied directly to me on personal application to medical men practising in the district.—F.W.B.

## Table II.—Summary of Returns received from Medical Officers of Health, &c.—*continued.*

| Registration District. | Sanitary District. | Cases of Enteric Fever reported to the Medical Officer of Health during the Fortnight ending | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Jan. 11. | Jan 25. | Feb. 8. | Feb. 22 | Mar. 8. | Mar. 22. | April 5. | April 19. | May 3. | May 17. | May 31. | June 14. | June 28. | July 12. | July 26. | Aug. 9. | Aug. 23. | Sept. 6. | Sept. 20. | Oct. 4. |
| 1. | 2. | 3. | 4. | 5. | 6. | 7. | 8. | 9. | 10. | 11. | 12. | 13. | 14. | 15. | 16. | 17. | 18. | 19. | 20. | 21. | 22. |
| Stockton-on-Tees | Stockon-on-Tees Urban | 5 | 11 | 10 | 11 | 11 | 13 | 12 | 7 | 4 | 7 | 4 | 5 | 8 | 4 | 6 | 6 | 3 | 12 | 50 | 62 |
| | Stockton Rural | — | — | — | 1 | — | — | 1 | 1 | 3 | — | 1 | — | — | — | — | 1 | 1 | 3 | 6 | 12 |
| | Sedgefield Rural* | 1 | 1 | 2 | 1 | — | 1 | 1 | — | — | — | — | — | — | 1 | — | — | — | — | 1 | 2 |
| | | 6 | 12 | 12 | 13 | 11 | 14 | 14 | 8 | 7 | 7 | 5 | 5 | 8 | 5 | 6 | 7 | 4 | 15 | 57 | 76 |
| Hartlepool | Hartlepool Urban | — | — | — | — | 1 | 1 | 1 | 2 | — | — | 2 | 2 | 1 | 5 | 5 | 2 | 2 | 1 | 3 | 2 |
| | West Hartlepool Urban | — | 3 | 2 | 1 | 1 | 5 | 1 | 2 | 2 | 2 | — | 2 | 2 | — | 1 | 1 | 3 | 1 | 3 | 3 |
| | Hartlepool Rural | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| | | — | 3 | 2 | 1 | 2 | 6 | 2 | 4 | 2 | 2 | 2 | 4 | 3 | 5 | 6 | 3 | 5 | 2 | 6 | 5 |
| Northallerton | Northallerton Urban* | — | — | 1 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| | Northallerton Rural* | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| | | — | — | 1 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| Stokesley | Stokesley Rural* | — | — | — | — | — | 1 | — | — | — | — | — | — | — | — | — | — | — | — | — | 2 |
| Middlesbrough | Middlesbrough Urban | 4 | 20 | 8 | 17 | 21 | 16 | 19 | 4 | 1 | 4 | 10 | 10 | 10 | 5 | 8 | 8 | 23 | 11 | 74 | 94 |
| | South Stockton Urban | 5 | 4 | 11 | 9 | 6 | 6 | 4 | — | 2 | 3 | — | — | 2 | 5 | 3 | 1 | — | 8 | 13 | 18 |
| | Ormesby Urban* | — | — | 1 | 1 | 10 | 1 | 1 | — | — | 2 | 5 | 2 | 1 | — | 1 | — | — | 3 | 9 | 11 |
| | Normanby Urban | 1 | 1 | 1 | 2 | 3 | 1 | 1 | 2 | — | — | — | — | 1 | — | — | — | — | 1 | 12 | 22 |
| | Eston Urban | — | 3 | 4 | 5 | 5 | 2 | 1 | 1 | 5 | 2 | 2 | — | 1 | 1 | — | 2 | 1 | 1 | 6 | 21 |
| | Middlesbrough Rural* | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| | | 10 | 28 | 25 | 34 | 45 | 26 | 26 | 7 | 8 | 11 | 18 | 12 | 15 | 11 | 12 | 11 | 24 | 24 | 114 | 166 |

* A number of the returns in question were based on data supplied to the Health Officer under the Notification Act or Acts. In certain districts, marked always in the table by an asterisk, "Notification" not being in force, the returns in questions are based on such data as had been obtained by the Medical Officers of Health, and also on information supplied directly to me on personal application to medical men practising in the district.—F.W.B.

## Table II.—Summary of Returns received from Medical Officers of Health, &c.—*continued.*

| Registration District. | Sanitary District. | Cases of Enteric Fever reported to the Medical Officer of Health during the Fortnight ending | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Jan. 11. | Jan. 25. | Feb. 8. | Feb. 22. | Mar. 8. | Mar. 22. | April 5. | April 19. | May 3. | May 17. | May 31. | June 14. | June 28. | July 12. | July 26. | Aug. 9. | Aug. 23. | Sept. 6. | Sept. 20. | Oct. 4. |
| 1. | 2. | 3. | 4. | 5. | 6. | 7. | 8. | 9. | 10. | 11. | 12. | 13. | 14. | 15. | 16. | 17. | 18. | 19. | 20. | 21. | 22. |
| Guisborough | Kirkleatham Urban | 1 | — | 1 | — | — | 1 | — | — | — | — | — | — | — | — | — | — | — | — | 1 | 6 |
| | Redcar Urban* | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| | Guisborough Urban* | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| | Skelton and Brotton Urban* | — | 5 | 1 | — | — | — | — | 2 | 1 | — | — | — | — | — | — | 1 | — | — | — | — |
| | Saltburn-by-the-Sea Urban* | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| | Loftus Urban* | — | — | — | — | — | — | — | — | — | — | — | — | — | 1 | 1 | — | — | — | — | — |
| | Guisborough Rural* | 3 | — | — | — | — | — | — | — | 1 | — | — | — | — | — | — | — | — | — | 1 | 1 |
| | | 4 | 5 | 2 | — | — | 1 | — | 2 | 2 | — | — | — | — | 1 | 1 | 1 | — | — | 2 | 7 |
| Richmond | Richmond Urban | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | 1 | — | — | — |
| | Richmond Rural | — | — | — | — | — | 3 | 1 | — | — | — | — | — | — | 1 | — | — | — | — | — | — |
| | | — | — | — | — | — | 3 | 1 | — | — | — | — | — | — | 1 | — | — | 1 | — | — | — |
| | Totals | 29 | 54 | 50 | 59 | 62 | 56 | 44 | 24 | 20 | 28 | 28 | 22 | 27 | 26 | 29 | 23 | 37 | 46 | 243 | 334 |

A number of the returns in question were based on data supplied to the Health Officer under the Notification Act or Acts. In certain districts, marked always in the table by an asterisk, "Notification" not being in force, the returns in question are based on such data as had been obtained by the Medical Officers of Health, and also on information supplied directly to me on personal application to medical men practising in the district.—F.W.B.

Upon sub-dividing the Registration Districts into their constituent sanitary districts further differentiation was obtained, as will be seen from the following approximate number of houses invaded per 1,000 houses in those districts during the four weeks in question:—Teesdale Rural, under ·5; Barnard Castle Urban, under 1; Auckland Rural, 2; Bishop Auckland Urban, 2; Shildon Urban, under ·5; Spennymoor Urban, under 1; Darlington Urban, 13; Darlington Rural, 5·5; Stockton-on-Tees Urban, 12; Stockton Rural, 9; Sedgefield Rural, 1; Hartlepool Urban, 2; West Hartlepool Urban, 1; Hartlepool Rural, nil; Northallerton Urban, nil; Northallerton Rural, nil; Stokesley Rural, under 1; Middlesbrough Urban, 12; South Stockton Urban, 11·5; Ormesby Urban, 11; Normanby Urban, 18; Eston Urban, 14; Middlesbrough Rural, nil; Kirkleatham Urban, 8; Redcar Urban, nil; Guisborough Urban, nil; Skelton and Brotton Urban, nil; Saltburn-by-the-Sea Urban, nil; Loftus Urban, nil; Guisborough Rural; 1·5; Richmond Urban, nil; and Richmond Rural, nil. From these figures it appears that the house attack rates were over the average in the Darlington, Stockton-on-Tees, Middlesbrough, South Stockton, Ormesby, Normanby, Eston, and Kirkleatham Urban, and in the Stockton rural sanitary districts: and that in the Darlington rural district the house attack rate, although ·5 below the average for the whole area, was more than double the rate obtaining in the next lowest district.

On further sub-division in similar fashion of the large towns of Darlington, Stockton-on-Tees, and Middlesbrough into their constituent wards (of which there are six in Darlington, ten in Stockton-on-Tees, and five in Middlesbrough), it was found that the house attack rate in each ward was, without exception, above the average, and further, that taking into account the smallness of the figures and the consequent liability to error, the rates so obtained proved the exceptional prevalence of the disease to have been fairly uniform throughout the whole area of each of the towns in question.

Differentiation of the same sort applied to the Rural Sanitary districts gave facts as follows: In the rural districts of Darlington and Stockton the special incidence of enteric fever was confined to certain townships and villages. In the Darlington rural, multiple attacks of houses were recorded only in the townships of Cockerton and Middleton St. George, whilst in the Stockton rural district no cases were notified anywhere, except in the villages of Norton, Haverton Hill, Port Clarence, and Stillington (Carlton Ironworks). In the Auckland rural district nearly the whole of the houses (some 20 in number) invaded by enteric fever were situated in the village of Crook, and this invasion took place during the last week of the period. In the Guisborough rural district two houses only were invaded, both situate in the village of Low Lackenby, which lies near to the Tees, between Eston and Kirkleatham.

Having ascertained these broad facts, it became necessary to inquire with respect to any circumstances possessed in common by the infected districts, and which were likely to have given rise to this sudden outbreak of enteric fever. Inquiry in this direction in one and another district as to a number of conditions that have elsewhere been convicted of disseminating enteric fever, failed, except in the matter of water supply, to discover among commonplace conditions any community of circumstance of the sort in question. Milk had to be dismissed as a possible channel of infection, the different sources of supply to the invaded houses numbering some scores. Each of the several urban districts, and so too the separate villages in the rural districts, had their

own systems of sewerage; in fact, some of the towns might be said to have several systems, whilst throughout the whole area affected, complete disconnexion between the sewers and the houses has been almost universally brought about during recent years. Further, the means of excrement disposal and of removal were found to vary considerably in the different districts. At Darlington old-fashioned uncovered privy middens sunk below the level of the ground and connected with the sewers are in vogue. At Stockton-on-Tees, South Stockton, and Ormesby, excrement and house refuse are usually disposed of in covered privy middens of comparatively small size; indeed at Stockton-on-Tees upwards of one-tenth of the houses are provided with waterclosets. At Middlesbrough, Normanby, and Eston, pan-closets are in use; whilst in the Kirkleatham district the houses are provided with waterclosets. In some of the districts, again, the emptying of the filth receptacles is undertaken by the sanitary authority at weekly or bi-weekly intervals, whilst in others the work of removal is done under contract, the intervals varying from once in a fortnight to once in one, two, or three months. The classes of houses invaded were very various; cases occurring in houses of all sorts, from the house of the poorest labourer to the mansion of the county Member. Houses also situate at different elevations were apparently indiscriminately invaded.

As regards water supply in the Area of Inquiry, the entire urban districts of Middlesbrough, Stockton-on-Tees, and South Stockton, as also portions of the urban districts of Normanby, Ormesby, Eston, Kirkleatham, with portions of the rural districts of Stockton, Guisborough, Stokesley, and Darlington, obtain their water from the works of the Stockton and Middlesbrough Water Board, whilst the whole urban district and a portion also of the rural district of Darlington are supplied from the mains of the Darlington Waterworks. Notwithstanding that the works referred to are separate, the source of the water is in both instances the same, namely, the River Tees; and the water is obtained from what is practically the same locality of this river, the intakes of the two works being situate within a few score yards one of another, at Broken Scaur, two miles above the town of Darlington.

Without entering into a detailed description of these separate waterworks, it may be noted that in each case the water is pumped direct from the river into subsidence tanks, and that it is afterwards filtered through sand and gravel before being delivered to consumers. The daily pumping at the Darlington works averages from 1,500,000 to 2,000,000 gallons, and at the Stockton and Middlesbrough works it averages about 9,000,000 gallons.

On the diagram map accompanying this report the area supplied with the Tees water is roughly indicated, and it will be found that exceptional fever prevalence in the Area of Inquiry during the four weeks ending October 4th was (save for a somewhat heavy incidence in far distant Crook during the last fortnight of the period) practically limited to the districts so supplied.

Having obtained this *primâ facie* evidence of limitation of the incidence of the enteric fever prevalence to the users of a particular water, I next obtained from the managers of the respective waterworks the number of houses supplied by them in the several districts. From the returns so obtained it appeared that in the whole Area of Inquiry upwards of 41,000 houses obtained their water supply from the River Tees, whilst some 56,000 houses were supplied from other sources.

During the four weeks ending October 4th some 500 houses supplied with water from the Tees were invaded by enteric fever, this number giving a house attack rate of about 12 per 1,000, whereas in the

56,000 houses obtaining their water supply from other sources, less than 50 were invaded by enteric fever during the same period, a number equivalent to a house attack rate of less than 1 per 1,000.

In this connexion it is to be noted that in the Darlington, Stockton-on-Tees, Middlesbrough, and South Stockton urban districts, where practically the whole of the houses obtain their water supply from the Tees, house invasions were, as already stated, 13, 12, 12, and 11·5 respectively per 1,000 houses, and it is to be noted that upon carrying the investigation further to the districts partially supplied with Tees water, the following rates of house attack were found to obtain amongst those sections of them receiving their supply from the Tees:—Darlington Rural, 27; Stockton Rural, 21; Ormesby Urban, 14; Eston Urban, 14; Normanby Urban, 21; Kirkleatham Urban, 10; Guisborough Rural, 54*; Stokesley Rural, 2·5 per 1,000; at the same time that within the same districts the house attack rates amongst users of other water were as follows:—Darlington Rural, 1; Stockton Rural, nil; Ormesby Urban, nil; Eston Urban,† 21; Normanby Urban,‡ 15; Middlesbrough Rural, nil; Guisborough Rural, nil; Kirkleatham Urban, nil; and Stokesley Rural, nil, per 1,000 houses.

Putting aside the two or three cases in which the numbers are so small as to give unreliable rates, it will be observed that exceptional incidence of attack has been almost entirely confined to the users of the Tees water. It will also be observed that in the larger districts the house attack rates were almost absolutely uniform.

It is further to be noted that several small clusters of houses supplied with Tees water escaped invasion, *e.g.*, Hartburn (51 houses); Elton (11 houses); Long Newton (9 houses); Preston (31 houses); Eaglescliffe Junction (7 houses); Urlay Nook (9 houses); and Eaglescliffe (61 houses), situate in the Stockton Rural District; whilst at Yarm in the Stokesley rural district, with 378 houses, only 1 was invaded, and that during the last week of the period ending October 4th. Assuming water to have been the carrier of the disease, it was to be expected, having regard to a particulate nature of enteric fever poison, that certain such small groups and clusters would escape invasion.

It is necessary to consider in some detail the circumstances of the River Tees in its course above the intake of the waterworks. Above Broken Scaur, where the intakes of the two waterworks are situate, the River Tees has a drainage area of upwards of 300 square miles, and the quantity of water flowing past the pumping station has been variously estimated at from 45,000,000 to 27,000,000 gallons per day in times of greatest drought. Upon this drainage area there is a scattered population of some 15,000 persons, in a large number of villages and detached farm houses. Within this area the River Tees receives either directly or indirectly the drainage of some 15 to 20 villages, as well as that of the town of Barnard Castle. A considerable proportion of the land in the drainage area is used for grazing purposes, and some of it is at certain periods of the year covered heavily with manure, of which an indefinite amount will undoubtedly find its way into the river. Many graveyards and farmsteads also add their quota of pollution to the stream:

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* Thirty-seven houses only supplied from the Tees, of which two invaded.

† Ninety-six houses only receiving supply from other sources than the Tees, of which two were invaded.

‡ One hundred and ninety-three houses obtaining their supply from other sources than the Tees, of which three were invaded.

but putting aside these general sources of pollution it will be necessary to consider briefly particular sources of foulness.

Taking, in the first instance, the north bank or Durham side of the river, about half a mile above the intake is situate the village of Low Coniscliffe (33 houses), the slop drainage from which is conveyed into an open pool or cesspit situate in an old river course of the Tees at a distance of about 50 yards from its present course. During periods of heavy rainfall a certain amount of this slop drainage passes into the river, whilst in very heavy floods the river actually overflows the portion of the field in which the pool is situate. Two and a half miles above the intake the Ulnaby Beck passes into the river. This beck conveys the slop drainage of High Coniscliffe (about 60 houses). At a distance of six miles from the intake is situated the village of Gainford, containing some 170 houses, many of which are of good class and furnished with waterclosets. Part of the drainage of this village is discharged directly into the Tees, but the major portion is conveyed in pipes to an open ditch running down the side of a field and having its outfall into the river. The soil through which this ditch passes is of a porous nature, and during dry weather the liquid portion of the sewage percolates into the land, whilst the solid filth accumulates and forms a black deposit in the bottom of the ditch. During heavy rain this black deposit is carried bodily into the Tees, and upon one occasion when I visited the outfall, a black streak could be clearly observed in the river for a considerable distance. About a mile above Gainford the River Tees is joined by the Alwent or Staindrop Beck. Some three miles above its confluence with the Tees this beck receives the drainage of the large village of Staindrop (upwards of 300 houses). The Staindrop drains are so constructed as to allow of considerable deposit, which is only washed out when they are either flushed artificially or during periods of heavy rain. Omitting other minor sources of pollution, with which I propose to deal more particularly in my complete report, the town of Barnard Castle is reached at a distance of 17 miles from the intake. Barnard Castle contains over 1,000 houses, and has an estimated population of from 5,000 to 6,000 persons. It is a market town, and during the summer months is a place much resorted to by the inhabitants of the northern seacoast towns as an inland watering-place. During the spring a regiment of militia undergoes its annual training here, the recruits being billeted in lodging-houses chiefly situate in the lower part of the town near to the river. Nearly 400 of the houses are provided with waterclosets. The town has been sewered throughout, and the outfall of the main sewer is directly into the Tees, about half a mile below the town. In addition to this source of pollution there are six privies situate directly on the bank of the river, which discharge their contents on to the foreshore. These privies serve a considerable number of houses, including common lodging-houses and houses in which militia recruits are billeted, situate in the lowest part of the town. The slop drainage from the majority of these houses is discharged by numerous drains directly on the foreshore, and here also ashes, house refuse, waste building material, and midden refuse have until a very recent period been deposited in considerable quantity. This foreshore during ordinary states of the river varies from 10 to 40 feet in width, and is only covered when the river is in flood. In the intervals between floods excrement, ashes, slops, and other filth accumulate in very considerable quantity: in fact, the whole of the foreshore becomes covered with a mass of stinking abominations which have to be seen and smelt to be appreciated. Above Barnard Castle, after omitting

a few farmhouses and the village of Eggleston, no great bulk of pollution passes into the Tees until Middleton-in-Teesdale is reached, some 10 miles higher up. Here again much sewage passes directly into the river, and two or three privies directly discharge their contents into it. The main drainage of Middleton is ostensibly conveyed on to land, but, as a matter of fact, the state of affairs here is very similar to that referred to as taking place at Gainford, the sewage passing into field ditches, where, in dry weather, the more liquid portion percolates into the land, and the solids are deposited in the ditches until such time as they are flushed bodily into the river during periods of heavy rainfall. Above Middleton-in-Teesdale, although there are no large aggregations of houses, the slop and farmyard drainage from many isolated farmhouses passes into the river.

Taking now the south or Yorkshire bank of the river, the sources of pollution are altogether much fewer and less gross than those on the Durham side. The slop drainage of many farmhouses and small villages finds its way into the becks and the rivers tributary to the Tees (Deepdale and Lartington Becks and Rivers Greta, Balder, and Lune), and thus adds some pollution to the river. At Startforth, however, situate immediately opposite the town of Barnard Castle, pollutions of similar nature, though of less extent than those noted at Barnard Castle, exist. The whole drainage of the villages of High and Low Startforth is discharged by means of several outfalls, either directly into the Tees or on a foreshore which exists on this side of the river similar to that already referred to on the Barnard Castle side. Here too some three or four privies discharge their contents, and upon this foreshore the drains from the stables attached to a public-house, and the discharges from an urinal erected by the Board of Health, are also received. The foreshore further serves as a common place of deposit for privy midden and house refuse. One accumulation of such filth was noted on the occasion of one of my visits which must have comprised from 10 to 15 cartloads. At Low Startforth is a mill giving employment to some 200 hands, for whose use some six or seven closets are provided, all of which discharge their contents directly into the river.

Without going into further detail, it will be clear that a considerable amount of excremental filth and house refuse is being continually poured into and conveyed down the river, and that the amount of polluting matter so carried down is enormously increased during periods of heavy rainfall when the river is in flood. It is to be noted that as regards the filth brought down from Barnard Castle and Startforth there has been, owing to changes in the river conditions, a notable increase during recent years when the river is in flood; for I understand from the medical officer of health for Barnard Castle that, prior to the year 1885, a weir known as "The Warrens" existed across the river at the lower end of the town, and that in consequence of this weir the river bed above it was always covered with water. So that at this time there was no foreshore, and the discharges from the privies and drains passed into the river in driblets, instead of accumulating, as at present, for considerable periods in the intervals between successive floods. A breach is stated to have been formed in this weir some five years ago, and this breach has been increased year after year until at the present time the weir as such is non-existent.

Having regard to the above conditions of the river, its foreshores, and its tributary streams and ditches, the question necessarily arose as to whether, during the three or four weeks prior to the date when the

sudden increase took place in the number of cases of enteric fever notified in the towns supplied with water from the river, there had occurred any exceptional circumstances of a nature to discharge wholesale into the Tees polluting matter that may have comprised the material of enteric fever.

Upon obtaining records of the rainfall from various observers in the Tees Valley it was at once seen that this question could be answered in the affirmative so far as a flood in the river was concerned. In the following Table III. will be found the rainfall at four stations in the Tees Valley, fortnight by fortnight, from the beginning of the year.

## Table III.

Rainfall in Inches observed in certain Stations in the Tees Valley, fortnight by fortnight, January 1st to September 20th, 1890.

| Fortnight ending | Barnard Castle. | Whorlton. | Mickleton. | Southend, Darlington. |
|---|---|---|---|---|
| January 11* - - | 1·515* | 1·20* | 1·70* | ·66* |
| „ 25 - - | 1·670 | 1·30 | 1·74 | 1·14 |
| February 8 - - | ·520 | ·45 | ·75 | ·49 |
| „ 22 - - | ·925 | 1·06 | ·62 | ·94 |
| March 8 - - | ·520 | ·35 | ·71 | ·20 |
| „ 22 - - | ·470 | ·63 | 1·01 | ·75 |
| April 5 - - - | 1·110 | 1·13 | 1·15 | ·86 |
| „ 19 - - - | ·540 | ·59 | ·28 | ·36 |
| May 3 - - - | ·795 | ·64 | ·94 | ·59 |
| „ 17 - - - | 1·645 | 1·72 | 1·43 | 1·67 |
| „ 31 - - - | ·390 | ·32 | ·49 | ·41 |
| June 14 - - - | 1·645 | 1·54 | 1·21 | ·89 |
| „ 28 - - - | ·535 | ·39 | ·44 | ·59 |
| July 12 - - - | 1·805 | 1·80 | 2·20 | 1·86 |
| „ 26 - - - | ·975 | 1·30 | ·67 | ·93 |
| August 9 - - | ·660 | ·67 | ·61 | ·40 |
| „ 23 - - | 3·660 | 3·15 | 4·35 | 3·21 |
| September 6 - - | 1·055 | ·99 | 1·18 | 1·62 |
| „ 20 - - | ·610 | ·56 | ·46 | ·58 |

* Eleven days only.

# Diagram Map
SHEWING THE
## Registration & Sanitary Districts,
*With the position of the principal Towns and Villages included therein situate immediately to the*
## North & South of the River Tees.

*Scale 4 miles to 1 inch.*

## References.

I Teesdale rural Sanitary district
II Auckland " " "
III Sedgefield " " "
IV Hartlepool " " "
V Darlington " " "
VI Stockton " " "
VII Middlesborough " " "
VIII Guisborough " " "
IX Stokesley " " "
X Northallerton " " "
XI Richmond " " "
1 Spennymoor Urban " "
2 Bishop Auckland " "
3 Shildon " " "
4 Barnard Castle " " "
5 Darlington " " "
6 Hartlepool " " "
7 West Hartlepool " " "
8 Stockton on Tees " "
9 South Stockton " " "
10 Middlesborough " " "
11 Ormesby " " "
12 Normanby " " "
13 Eston " " "
14 Kirkleatham " " "
15 Redcar " " "
16 Guisborough " " "
17 Skelton & Brotton " "
18 Saltburn by the Sea " "
19 Loftus " " "
20 Northallerton " " "
21 Richmond " " "

Villages containing under 50 Houses
" from 50 to 100 Houses
" 100 to 250 Houses
" 250 to 500 Houses
Towns " 500 to 1000 Houses
" " 1000 to 2500 Houses
" " 2500 to 5000 Houses
" " 5000 to 10000 Houses
" " upwards of 10000 Houses

Boundaries of Urban Sanitary Districts.
Boundaries of Registration Districts.
Towns or Villages supplied with water from River Tees.
Houses supplied with Tees Water invaded by Enteric Fever during period September 7th to October 4th 1890.
Houses supplied from other sources than River Tees invaded by Enteric Fever during period September 7th to October 4th 1890.
+ Houses invaded after removal to them of persons from Tees districts.

From the above table it will be observed that the heaviest rainfall recorded in the Tees Valley during the period under review occurred in the fortnight ending August 23rd, when the amount varied at the different stations from upwards of three to upwards of four inches. According to observations made on behalf of the Tees Fishery Board it appears that the river was in "heavy flood" on the 13th and 23rd of August respectively; the last occasion prior to August 13th when a "heavy flood" had been recorded being on May 17th, nearly three months earlier. In the interval there had no doubt been several occasions of much rain. Thus the rainfall at Barnard Castle during the fortnights ended June 14th, July 12th, and July 26th, was above the fortnightly average. But on reference to the daily register the fall was found to have been spread over a number of days in each of the fortnights in question, whereas in the fortnights ending May 17th and August 23rd, the bulk of the rain fell on two or three consecutive days only. In view of the facts I have recorded as to excremental and other refuse stored on the banks and in the neighbourhood of the Tees at points above the intakes of the waterworks, and ready to be swept into the stream on the occasion of the next ensuing flood, the heavy rainfall which occurred during the fortnight ending August 23rd is a noteworthy circumstance exactly parallel (making allowance for what is known as to the incubation period of enteric fever) to the observed sudden diffusion of fever in all the districts supplied with Tees water.

Liability of the Tees to dangerous fouling has long been admitted. The amount of the pollution passing into the Tees above the intake was indeed, as regards the Stockton and Middlesbrough sanitary authorities, a matter of common knowledge as far back as 1876. At that date these authorities applied to Parliament for authority to purchase compulsorily the waterworks from the company in whose possession they then were, the polluted condition of the river water being one of the chief grounds upon which the authorities based their application, and in support of which they brought forward a mass of evidence.

As regards the Darlington sanitary authority too, special investigations were made in 1887 with a view of ascertaining the differing quality of the river water at ordinary level and in times of flood, and short extracts from the reports of Professor Hare and of Mr. W. F. K. Stock, public analyst for the county of Durham, employed by the Sanitary Authority to examine the water by biological and chemical tests respectively, will be of interest. Professor Hare stated the general result of his observations as follows:—

"(1.) On the occasion of a sudden rise of the river's flow, and for 40 "hours after its onset, there is a great increase in the organic "matter present in the Tees water at the pumping station, "and there is at such a period evidence of the abundant "presence of unaltered sewage matter.

"(2.) The filtering processes carried on at the waterworks greatly "reduce the amount of organic matter in the water as "supplied to consumers; but during a period of high water "in the river, the water as supplied in the town shows the "presence of organic matter which is in part composed of "fresh sewage material."

Mr. Stock, after giving a number of analyses, and reporting generally on the chemical constituents of the river water, arrived at the following general conclusion with respect to the river water during flood time:—

"I find first a decided access of sewage due to Barnard Castle, and "second, the existence of sewage matter in an unaltered condition

" at the Darlington Corporation's intake. It must be understood " that when I speak of sewage, I class under this description town " refuse of various kinds with the actual contents of the sewers, " and I have no doubt whatever that the pollution found in the " Tees at Darlington during partial flood is very largely due to " filth washed down from Barnard Castle; to say nothing of the " total sewerage of that town falling directly into the river, the " whole riverside population on both* sides use the stream as a " common depository for all kinds of unmentionable abominations. " I speak from my own knowledge, and I say without fear or " favour that the way in which the Tees water is seasoned at " Barnard Castle for use by the inhabitants at Darlington is " absolutely scandalous."

There is, moreover, recent chemical evidence which shows that at a period very shortly after the flood of August 13th, 1890, the Tees water contained an excess of organic matter. The two following analyses were made of water collected in Middlesbrough on August 18th, 1890, or five days subsequent to the flood of August 13th, and on October 15th, 1890, respectively by Dr. Frankland, at the instance of the Stockton and Middlesbrough Water Board, and published by them as testimony to the purity of the water.

Table IV.

Results of Analyses (expressed in parts per 100,000) of Water from the Stockton and Middlesbrough Waterworks, made by Dr. E. Frankland in August and October, 1890.

| Description. | Total Solid Matter. | Organic Carbon. | Organic Nitrogen. | Ammonia. | Nitrogen as Nitrates and Nitrites. | Total combined Nitrogen. | Previous Sewage or Animal contamination. | Chlorine. | Hardness. | | | Remarks. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | Temporary. | Permanent. | Total. | |
| Sample of water drawn from tap in yard in Upper Albert Road, Middlesbrough, 18th August 1890. —D.D.W. | 10·52 | 1·005 | ·067 | — | — | ·067 | — | 0·7 | — | 5·6 | 5·6 | Peaty taste, turbid pale brown in colour. |
| Sample of water taken from an ordinary tap in the back yard of 70, Richardson Street, Middlesbrough, October 15th, 1890. | 12·96 | ·424 | ·015 | — | — | ·015 | — | 0·8 | 2·7 | 6·0 | 8·7 | Veryslightly turbid, peatytaste. |

From the above analyses it will be seen that the water collected in August, although shown by the amount of solid matter and by the degrees of hardness to be more dilute than that collected in October, contained more than double the amount of organic carbon, and four

* At the time when this report was written Startforth was included within the district of the Barnard Castle Board of Health.

times the amount of organic nitrogen than the second sample, whilst in neither had any oxidation of the organic matter apparently taken place.

But whatever the customary quality of the water distributed by the works in question, there can be no doubt that, during the fortnight ending August 23rd, water containing an excessive amount of organic matter, much of it of excremental nature, was pumped from the River Tees; nor that three to four weeks later the number of cases of enteric fever notified* as occurring in South Durham and North Yorkshire amongst the consumers of that water amounted to an epidemic outburst of the disease. So, too, there can be no question that this epidemic prevalence of enteric fever was practically confined to the consumers of Tees water, that the houses supplied with that water were invaded in an almost uniform proportion throughout the sanitary districts supplied with it, and finally that these districts had no other circumstances in common which could be regarded as an at all likely medium for the conveyance of the specific poison.

All this is independent of the fact that with the exception of two cases of enteric fever occurring in Barnard Castle in the first week of September, there are no reliable records of the presence of the disease in any of the towns or villages above the intakes of these waterworks, immediately prior to the outbreak. But it is a matter of common knowledge that slight attacks of enteric fever are frequently unrecognised; and when it is remembered that several of the towns and villages above the intake have a considerable floating population throughout the summer months, and that a steady stream of tramps is continually passing through the district, attracted by the extensive waterworks now in course of construction for the Stockton and Middlesbrough Water Board in the valley of the Balder, it is not to be denied that unrecorded opportunities for the introduction of specific material of enteric fever into the upper reaches of the Tees may have been many.

From a consideration of all the circumstances of the case, I have personally no hesitation in attributing the epidemic of enteric fever in the Lower Tees Valley to the water pumped from the River Tees during the fortnight ending August 23rd, at a time, namely, when the river was in flood and when it must have contained abundance of excremental matter. And I consider that so long as water for drinking purposes is drawn from the Tees, the condition of that river remaining as at present, so long will there be danger of the occurrence of similar epidemics to that described in this report in the districts thus supplied with Tees water.

There can be no question that if the sewage and excremental and other refuse of the various towns and villages above the pumping station were prevented from passing into the Tees, the danger of specific pollution of the water would be very greatly reduced; but even under these circumstances it is still doubtful whether a water pumped from a river at a point upwards of 40 miles from its source is, anywhere in this country, a desirable supply for drinking purposes.

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* It will be observed that in all the figures with regard to the disease prevalence I have given the *date of notification* and not *date of attack*, it being found impracticable at the time of my inquiry to obtain reliable information as to the latter date. Taking into account the period of incubation and the time which would elapse before the doctor was called in, and the case "notified," it may be assumed that not less than three, and very likely four, weeks would elapse between the date of infection and of notification.

Until some very decided improvement is effected, either in the river conditions or in the source of the water supply, it will be advisable for persons residing in the towns recently infected by enteric fever to boil all water prior to its use for drinking purposes. In this sense I have already advised the several sanitary authorities concerned.

No. 9.



## On an Outbreak of Diphtheria at Berkhampstead, Herts, and upon the Sewerage of the Town; by Dr. Blaxall.



This inquiry was instituted in consequence of the Board having received information of an outbreak of diphtheria at Berkhampstead, affecting especially the Grammar School. It was supposed to be in some way related to defective sewerage.

Berkhampstead is a small town situated in the Berkhampstead rural sanitary district, under the jurisdiction of the Berkhampstead Rural Sanitary Authority. They have appointed a parochial committee to act for them in the town under the Public Health Act, 1875, section 202. The population is estimated at 5,500 persons. The town stands on the chalk formation. The principal street (High Street) running from N.W. to S.E. is about a mile in length, somewhat undulating, and intersected by several smaller streets. The Grand Junction Canal lies on the N. of the town, and between this and High Street flows the Bulbourne stream, running almost parallel to High Street but at a lower level, and entering the canal at the east end of the town.

King Edward's Grammar School stands in Castle Street, near the centre of the town, between High Street and the stream. The strength of the school is about 190 boys, of whom 98 are boarders, and the rest day scholars. The boarders reside in three separate houses, 64 living in the school-house in Castle Street with the head master, the Rev. T. C. Fry; and 19 and 15 respectively in two boarding-houses in High Street kept by assistant masters, Messrs. Fricker and Gowring. Of the 92 day boys, 58 reside in the town and 34 in the surrounding neighbourhood, coming in daily by train to attend school.

I commenced my inquiry at Berkhampstead on February 1st, 1890, when I placed myself in communication with Dr. Thompson, Medical Officer of Health, and the several medical practitioners of the town, who kindly supplied me with information respecting the several cases of throat illness that had come under their observation from September to December last inclusive. The teachers of the board and national schools likewise furnished me with the names of children who had absented themselves from school during the same period on account of sickness.

I did not hear of the presence of any throat illness in the town prior to September 18th. This was the date of the re-assembling of the Grammar School.

Two cases have especial interest for the inquirer into the origin of the disease: one was the case of somebody, a boarder at the school, who first came under medical treatment for a sore throat during the last week of September; the other was a day scholar (H. T.) living at Kitsbury, a suburb of Berkampstead, who stayed at home on September 24th on account of sore throat. The former case will come under consideration in the course of this report, but of the other case, as being

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On Diphtheria at Berkhampstead; by Dr. Blaxall.

earlier in point of his first definite symptoms, I proceed to give a more particular account.

The Kitsbury family consisted of husband, wife, and five children, three boys (of whom H. T. was the second), two girls, and two servants. The ages of the children ranged between 9 and 14 years. The three boys all went to the Grammar School. H. T. was kept at home from September 24th to October 16th, when he returned to school for two days. In the meanwhile, early in October, his mother and one of his sisters were attacked with throat illness, followed on the 7th October by the eldest brother, who up to that date had continued to attend school. On October 9th, Mrs. T.'s illness was pronounced by her medical attendant to be diphtheria; subsequently the other sister was attacked, and lastly, on October 19th, the youngest boy, who up to that date had gone to school daily. This boy and his mother both suffered from diphtheritic paralysis. It should be noted that Mrs. T. had suffered from diphtheria some 20 years before, and all the family were subject to sore throats.

After this there was no further case of recognised diphtheria in the town until December 3rd; but it is in evidence that throat illness of more or less severity had continued present in the Grammar School, commencing shortly after the re-assembling of the boys. The attacks occurred in irregular sequence, viz., on September 24th (H. T., before mentioned), 26th, 30th; October 2nd, 7th, 19th (the last two being H. T.'s brothers), 23rd, 26th; November 1st, 2nd, 4th, 11th, 13th, 18th, 22nd, 25th, 26th, and December 2nd. All the foregoing cases, with the exception of H. T. and his brothers, occurred in boarders living in one or other of the grammar school-houses. The cases were of an ill-defined character. The head master, indeed, expressed doubt as to whether certain ailments could properly be spoken of as "throat illness" at all.

After December 2nd the character of the disease changed, typical diphtheria of a virulent and fatal form manifesting itself, attacking first a day boy, G. A., on December 3rd, who died on December 13th. On December 5th, three cases of ill-defined throat illness occurred amongst the boarders. December 8th, a boarder was taken ill with what ultimately proved to be nasal diphtheria. [Unfortunately the nature of the attack was not recognised and the boy was sent to his home, with the sad result of his mother and two of his sisters contracting diphtheria and dying.] On December 9th, an assistant master lodging in the town was attacked. On the 11th, six boarders and one day scholar, one boarder dying. On the 13th, one boarder and one day scholar began to be ill. On the 14th the school was broken up, two boarders manifesting diphtheria after arrival at their homes, and one case proving fatal.

Altogether, inclusive of the recognised diphtheria cases, there was a total of 40 cases of throat illness, of which 30 occurred in boarders, four in day scholars, one in an assistant master lodging in the town, and the remaining five in the family of the day scholar, H. T. No case of diphtheria occurred in the town after the school was dispersed.

The children of the board and national schools were, according to the testimony of the teachers, exceptionally healthy during the term. The teachers did not remember any cases of sore throat amongst the children; but the lists of the National School showed some cases of mumps in a family commencing on 20th September. Remembering my experience elsewhere of so-called mumps having been followed by marked diphtheritic paralysis, I made careful inquiry into the history of these cases, with the result of satisfying myself that there was

nothing to justify suspicion that diphtheria had been present in these cases. So they may be dismissed from further consideration.—The doctors' lists show that two families, residing in the town, but unconnected with the Grammar School, were attacked with throat illness, one on November 14th the other on December 10th. In the first family the mother was first attacked, followed by her two children, a circumstance suggesting that the woman's throat illness might have been contagious in character. But her symptoms were not such as usually belong to throat disease of any infective sort. She had great difficulty in swallowing till "something burst in her throat, which afforded instant relief," probably an abscess in the tonsil. The case of the 10th December occurred in a man who was the only one attacked out of a family of five or six persons, including two children. My inquiry into the particulars of the case went to confirm the opinion of the medical attendant as to the non-diphtheritic character of the illness.

It has been mentioned that the origin of the outbreak was attributed to nuisance caused by defective sewerage of the town. The assistant master and some of the boys who suffered from diphtheria made special complaint of the stinks emanating from the sewers in Castle Street.

The sewerage of the town, as will presently be shown, is of the most defective character, giving rise to nuisances that are everywhere prevalent to a greater or less degree. Yet I heard of only two families unconnected with the Grammar School who had come under medical treatment for throat illness, and this apparently not of a diphtheritic character. Again, persons passing through Castle Street on their way to and from the railway station or elsewhere, including those 35 day scholars who come in daily by train, are exposed to these sewage nuisances, and they all escaped. If sewer stinks in the specially offensive Castle Street were to be held responsible for the diphtheria in the assistant master and boys who complained of the stinks, diphtheria would have to be looked for equally amongst the residents of that locality, as well as amongst a notable number of persons frequenting the street. Yet I could hear of no such cases. On review of the whole case, it appears to me that stinks from the sewers must be excluded from having played any direct part in the dissemination of the disease. In like manner milk supply and domestic animals, channels by which diphtheria at other places has been found to be spread, can be dismissed. The water supply, too, may be absolved.

[The sanitary condition of H. T.'s home demands consideration, seeing that his throat illness was followed by five other cases in his family, including two typical cases of diphtheria. The drainage of this house is conveyed by a sewer to the Bulbourne stream to the west of the town, and is quite distinct from the town sewerage. The dwelling was at times rendered offensive, especially one small room in which Mrs. T. was in the habit of sitting with her boys when they prepared their lessons, by reason of a faulty closet, the contents of which went into a catchpit under the flooring of the closet; this had become broken, admitting the escape of sewer air into the house. The question arises whether the six cases of throat illness in this family were due to the unwholesome condition of the dwelling. Against this view I mention, for what it is worth, the escape of all throat illness amongst the occupants of other dwellings that drained into the same sewer.]

Reverting to the conditions of the Grammar School soon after its re-assembling on September 18th, I would say that it is not to be taken for granted, because H. T. was the first scholar to show a sore throat that the diphtheria originated with him. He was, it will be remembered,

the earliest person in his household to be attacked, and it is quite possible that he was only the first of the school series, and got the complaint, like later cases, from some common infection of the school. And here we may see the interest of the other case, some boarder of whom I have previously spoken as coming first under medical treatment for a sore throat in the last week of September. One boarder made some complaint on the 26th, and it would hardly be safe to deny that that boy may have introduced the infection into the school. And a similar, and perhaps stronger, suspicion may attach to the case of another scholar, who first complained of his throat on the 30th instant; he was a boy (B.) who had been habitually subject to sore throats ever since he had had diphtheria, some five years before, so that it is not improbable that this boy's throat was bad some few days before he applied for medical treatment. Even if we should not accept the opinion advanced by some authorities that diphtheria poison may continue dormant in the system for an indefinite period after the first attack, we may yet believe that in B.'s case his throat was in an infectious condition at an early (hardly noticeable) phase of his ailment. Looking at the whole evidence, as it presents itself to me, it seems to point very strongly to the school itself as being in some way concerned in the origin of the disease, the introduction being probably effected by some unrecognised case at the time of the re-assembling of the school.

The continuance of sore throat amongst the school boys, notably the boarders, could not be ascribed to any fault in the sanitary condition of the three school dwellings. Of the school-house itself, the general drainage arrangements were satisfactory. They had been carefully carried out, and included the cutting off of air communication with the sewer, the provision of efficient ventilation and flushing of drains and closets, and severing connexion of sink and bath pipes from drains. It is true that on examination of the main drain after the school had been dispersed, some joints were found to be defective, and had to be made good; but they were at a depth of some 4 or 5 feet from the surface, and cannot be supposed to have been concerned in the throat illness. The boarding-houses, on the contrary, were not so satisfactory. One house had a cess-pit privy on the premises, and the other had a closet which drained into a cess-pit, and the house drain in faulty connexion with the sewer.*

Whether the change in the type of the disease after December 2nd was dependent upon any peculiar atmospheric or other condition, or to any idiosyncracy of constitution, there was nothing to show;† but after this, diphtheria spread rapidly amongst the boys, favoured no doubt by the same intermingling of infected and healthy in the school as had

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* These conditions have since been amended.

† As already stated, throat illness continued in the school till December 3rd, when G. A., one of the day scholars, was attacked with typical diphtheria. I made careful inquiry into the history of this case, and found that G. A. had played in a football match at King's Langley on November 30th (*i.e.*, three days before his attack), but so far as I could learn, by inquiry of the medical men practising in that neighbourhood and otherwise, there was no probability of exposure to the infection of diphtheria on that occasion. Thinking he might have incurred risk of such exposure by visiting the house of H. T., infected in October, I made inquiry in that direction, with the result of finding he had had no intercourse with them, as the T. family went to the sea-side during convalescence, and did not return home after G. A.'s attack. Failing evidence of any other channel of infection to which G. A. was exposed, it would seem that the diphtheria in his case was intimately related to the previous and protracted throat illness in the school.

operated all along in keeping up the throat illness. The first sufferer from this more serious type of disease had attended choir practice on Sunday, December 1st, and had there been brought into close contact with the assistant master and four or five boys, who were all subsequently attacked with diphtheria. Thus it appears to me that, just as the weight of evidence favours the conclusion that throat illness owed its introduction to some infected boy from home, so the dissemination was due to infected and healthy being brought together in the school. This conclusion is quite in keeping with experience elsewhere, it being no uncommon thing to find ill-defined throat illness obtaining in schools for a time, and ending in typical diphtheria; especially has this been found to be case in the autumn, the season when these cases occurred. These facts should impress upon school authorities the importance of regarding any throat illness with suspicion, and the necessity of skilled observation, with the adoption of measures of isolation for cases that may have infective quality.

*Sewerage and Drainage.*—The sewerage and drainage of the town, as already said, is of a most defective character, involving faults in construction, and a method of disposal of sewage fraught with nuisance injurious to health. The main sewer which runs along High Street is merely an old brick sewer originally laid down by the highway authorities at a depth of about two feet for the conveyance of surface water, and is utterly unfitted for the purpose of carrying off sewage; it permits leakage, and it favours deposit. I had the sewer opened in two places, when I found some four inches of thick black mud at each place. This sewer receives the contents of various branch sewers from the streets on the south, and gives off sewers on the north which pass down certain streets, and ultimately discharge into the stream. The principal of these is the sewer which goes down Castle Street and empties into the stream on the east side of the bridge. Another sewer takes the sewage from the west end of the main sewer, and ultimately enters the stream on the west side of the bridge. This sewer is actually provided with two catchpits for the subsidence of the solids; the large catchpit being only a few feet removed from cottages, and giving rise to intolerable emanations, especially during the time of removal of the solid contents. I received loud complaints of the nuisance caused by the sewer outlets, which is said to be intensified by the admixture of hot brewery refuse.

The branch sewers are said to be constructed of glazed pipes. But no provision is made for the ventilation or flushing of the sewers.

From the foregoing it will been seen that the Berkhampstead Sanitary Authority have failed to fulfil the requirements of the Public Health Act, 1875, sections 15 and 19. That the evidence of this report goes to exculpate the sewerage evils existing in this town from direct concern in the causation and spread of throat illness on this occasion does not constitute the smallest justification for the present state of the sewerage. Not only is its condition a distinct violation of law, and a standing cause of offence and other danger to health, but its condition is such as to ensure the spread of such diseases as cholera and typhoid fever should they by chance be introduced into the town. Nor is mischief from the present condition of Berkhampstead sewers limited to the town itself, for the stream empties into the canal at the east end of the town, polluting its waters with foul and dangerous sewage. It, therefore, behoves the Authority to adopt immediate remedial measures by the substitution of efficient sewerage and drainage, and to lose no time in obtaining the advice of a skilled engineer as to the means of gaining this efficiency.

In conclusion, I would express my sincere thanks to the head master, the Reverend T. C. Fry, the several medical practitioners, Messrs. Hobson, Batterbury, and Bontor, also to the teachers of the board and national schools, for their courteous and ready assistance in affording me information. My thanks are also greatly due to Dr. Thompson, the Medical Officer of Health, who accompanied me throughout my inquiry, and whose previous investigation had to a great extent cleared the way for me.

## No. 10.

On Prevalence of Diphtheria and "Croup" in the Stalybridge Urban Sanitary District, and upon the General Sanitary Circumstances of the District; by Mr. Spear.

The urban district of Stalybridge covers an area of 3,071 acres, and contains a population, mainly aggregated on the western border of the district, now estimated at 28,000. On the west is Ashton-under-Lyne (the two towns being almost continuous); on the south and south-west are the Dukinfield and Hyde Urban Districts; on the north and north-west, the Mossley and Hurst Urban Districts; and on the east is an elevated and for some distance sparsely populated tract of country. The River Tame and the Huddersfield Canal pass side by side through a valley which cuts the district in an east and west direction, and upon the somewhat steep sides of which the town is situated. Geologically, the western and more populous borders of the district are on the Lower Coal Measures or Gannister Beds; the eastern part on the Mill Stone Grit and Shale. The surface soil is chiefly clay and shale. Cotton mills supply the staple industry.

Mortality statistics of the district during recent years are given below :—

| Year. | Deaths from all Causes per 1,000 of Population. | Deaths under 1 to 1,000 Births. | Number of Deaths from | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Small-pox. | Measles | Scarla-tina. | Diph-theria. | Croup. | Whooping Cough. | Fever. | Diar-rhœa. |
| 1880 - | 21·6 | | — | 13 | 6 | 1 | ? | 9 | 8 | 38 |
| 1881 - | 22·6 | | — | — | 9 | — | ? | 16 | 7 | 27 |
| 1882 - | 22·2 | | — | 6 | 8 | — | 3 | 30 | 12 | 34 |
| 1883 - | 21·5 | | — | 4 | 9 | — | 6 | — | 8 | 15 |
| 1884 - | 26·1 | 184 | — | 6 | 29 | — | 6 | 11 | 6 | 45 |
| 1885 - | 23·3 | 175 | — | 7 | 3 | — | 1 | 28 | 4 | 16 |
| 1886 - | 22·5 | 194 | — | 1 | 1 | — | 2 | 22 | 11 | 21 |
| 1887 - | 23·6 | 162 | — | 68 | 3 | 1 | 3 | 5 | 1 | 19 |
| 1888 - | 20·2 | 161 | 2 | — | 8 | — | 3 | 9 | 7 | 18 |
| 1889 - | 23·2 | 205 | — | 41 | 9 | 7 | 17 | 4 | 4 | 18 |

The most notable features of this table are the high general mortality shown, the high infant mortality, the endemic prevalence of "fever" (apparently all typhoid), the large increase in the mortality from diphtheria during 1889, and the coincident large increase in the mortality from "croup." During 1889, in addition to the deaths above recorded, four were registered from "laryngitis" or "laryngitis, tonsillitis"; and during the first two months of 1890 two deaths from diphtheria were registered and two from "croup." Investigation of the circumstances of this recent fatal prevalence of throat diseases was the chief purpose of my inquiry.

So far as I could learn, the number of non-fatal cases of diphtheria, or of other sore throat, had been, relatively to the deaths, remarkably few. A system of compulsory notification of infectious diseases (diphtheria but not croup being amongst those scheduled) is in force in the district, but, except for those that proved fatal no single case of diphtheria had been reported to the authority. One medical man practising in the district told me that during 1889 he had had three or four cases

of what he regarded as inflammatory croup terminating in recovery, and another that he had had two or three cases of severe sore throat that he considered suspicious of diphtheria. In one house I myself found a child suffering from a sore throat that I regarded as diphtheritic, and I learned that the mother had suffered similarly before. In only three houses where a fatal attack or fatal attacks occurred, either of diphtheria, or "croup," or laryngitis, did I find that other members of the family had suffered from *non-fatal* sore throat. The disease was undoubtedly very fatal, and with few exceptions death occurred within three or four days of seizure, or at least of the occurrence of any noticeable symptoms.

There can be little doubt that many of the so-called cases of "croup" were cases of true diphtheria. The history of the household invasion, alone, was in several cases strongly suggestive of this. Thus:—

In one family, within a week, two children died from "croup," and another from "tracheitis" (so certified). [One medical man who saw the last-named case assures me that it was without doubt a case of diphtheria, and certified it as such to the authority. A fourth death in the family three weeks later is not without suspicion; it was certified as due to "broncho-pneumonia."]

In a second family, two children died within two days of each other, of what was certified as "croup."

In a third, within a month, one child died of what was certified as "croup," and another from what was certified as "laryngitis."

In a fourth, two children died within a week of each other from "croup," and another a week later from "pyrexia, irritation of the brain."

In a fifth, three children died within a week; the deaths in two cases being ascribed to "laryngitis, tracheitis," in the other to "malformation."

As to age, 32 fatal cases may be classified:—Under one year, one; one to two, four; two to four, 16; four to eight, nine; eight to ten, two.

I could not trace the various family outbreaks of diphtheria to any common source, nor, in the great majority of cases, was any chain of infection discoverable. So far as I could find, the earliest family invasion of the series occurred in November 1888, when in the course of a week, two children of a family living in Kenworth Street died from what was certified as "croup." I could not discover that these children had been exposed to any risk of direct infection; although it has to be noted that in the neighbouring districts of Saddleworth Rural and Upper Mill Urban diphtheria was then, and in Upper Mill had been for some time, prevalent.* The next known case was in Grosvenor Street (the same locality), and the child, who was certified likewise to have died from "croup," had been a playfellow of the previously deceased children, and had visited their house. Subsequently, the monthly list of family invasions (from diphtheria, "croup," and "laryngitis") was as follows:—January, one; February, two; March, five; April, three; May, one; August, two; September, one; October, five; November, one; December, two; January (1890), one; February, three. I did not find much evidence of the extension of infection through the attendance of children at school. Three of the October cases were amongst children attending one school; on the other hand, of the total number of initial sufferers, eleven were amongst non-attendants. There was no significant community of milk supply. As to

* It should also be mentioned that sewer air was found blowing into the house through an internal gully connexion, a defect that remained unremedied at the time of my visit many months later.

locality, the disease was widely distributed throughout the town, although certain quarters suffered more than others. In a large proportion of the cases it was noticed that the infected houses were exposed, through direct connexions with the sewers, to the entrance of drain and sewer air. To this matter I will again refer.

## Sanitary Condition of the District.

*Sewerage and Drainage.*—The district is sewered chiefly by pipe sewers, but partly by brick and stone channels all emptying by many different outlets into the river as it passes through the town. Some years ago, owing, it is said, to the entire absence of ventilation of the sewers, two men working in one of them lost their lives; and since then they have been ventilated at various points by open man-holes, while the authority have likewise favoured the plan—one that is open to grave objection—of connecting with the sewers rain-water spouts from the roofs of houses. There are evidently many branch sewers that are still without ventilation or that are ventilated only by the ineffective and objectionable method last referred to. Waterclosets are uncommon (there are only some 60 in the town), but a large proportion of the middensteads are drained into the public sewers; this mistaken and mischievous plan of dealing with sloppy midden-privies having been adopted by the authority some ten years ago, and for a while actively enforced.

During the last five years direct connexions between the interior of houses and the sewers have been severed in more than 1,000 cases, and it was believed that the greater part of this work had been accomplished. Nevertheless, direct connexion by kitchen slop-stone or by cellar gully, sometimes even without the intervention of a trap, was found in 13 of the houses invaded by diphtheria or "croup" during the recent prevalence, or in nearly 50 per cent. of their number; while in five others untrapped or defective drains existed in such close proximity to the doors and windows as to produce practically the same result as if the drain had been within the house. In most of the above cases, in fact, it was obvious that the houses were habitually invaded by sewer air, and in three cases in which the experiment was tried the draught coming from the drain was sufficiently strong to extinguish a lighted candle applied to the opening.

Sewage is discharged, as I have said, into the River Tame by numerous outlets. The Tame is a somewhat broad but very shallow stream, and in summer, when the weather is at all dry, the flow of water is much diminished. Nuisance then arises, and the people along the banks complain. Below Stalybridge the stream passes through Ashton and other populous places, serving throughout as an open sewer.

*Refuse Disposal.*—The system of privy-middens is in general use in the district. The middens are generally very large and deep, often sloppy, and in many places in exceedingly confined situations. In 1879 and for some years after the authority, as already explained, required the drainage of middensteads; but this plan being found a failure (as might have been anticipated had the experience of other places been consulted), in January 1888 it was decided that all new middens or those requiring re-construction should be made water-tight and roofed over. The prescribed size of the structure was still excessive, that of the ashpit alone being *not less than* 15 *square feet;* and although deep excavations were now abandoned the floor of the middens was still to be sunk 12 inches below the ground level. The principal requi re-

ments of a well constructed receptacle for filth were, in short, ignored; and the new middens, although showing some improvement over the old, are a source of much nuisance.

About 1885 the authority, recognising the insufficient amount of closet accommodation in certain quarters of the town, decided that at least one privy to three houses ought to be provided. The action that followed in order to secure this result was by no means universal, and it is fortunate that this was so having regard to the structural nature of the accommodation it was still the fashion to provide. Some of the worst examples to be found in the town of foul middens hemmed-in by already overcrowded property have been supplied by the enforcement of the above-mentioned rule.

In a very few cases a real improvement has been effected by the abolition of the old privy and the substitution of one of the box or tub variety. Even in these cases, however, the large ashpit has been retained.

The authority provide for the removal of refuse, and employ a staff of men with horses and carts for the purpose. The removal is not effected systematically, but on complaint either of the inspector or of the householder. By a singular arrangement, too, for a sanitary authority, a fixed charge is made for each visit of the scavengers.

*Water Supply.*—A public water supply, provided in 1884, is available in all parts of the town. The works are owned by Stalybridge, Ashton, and other neighbouring authorities. There are two reservoirs, both being fed from moorland surface water of similar character. Stalybridge, together with a part of Ashton and certain outlying districts, is supplied from the Swinshaw reservoir. The supply is said to be abundant and is laid on at constant pressure.

*House Accommodation.*—There is a considerable amount of crowding of buildings upon area at Stalybridge. Courts, some of them entered by covered ways, are numerous. There are a number of back-to-back houses, and many more without through ventilation. Some of the courts are exceedingly close and confined, and yet a considerable proportion of their area is allowed to be occupied by accumulations of excrement and other filth in large and deep middensteads. Many houses in the town derive their sole air supply from such confined and befouled spaces, and are rendered unfit for human habitation in consequence. Even as regards the houses that abut upon the public streets a similar condition of things is often found at their rear—a space enclosed on every side, and within it, occupying a large proportion of the area, and close by the back doors and windows, foul middensteads.

In addition to these defects of surroundings, many of the cottages of the district are very small, ill-ventilated, and ill-lighted; some, having regard to the paucity of accommodation, are overcrowded.

*Lodging-houses.*—No attempt has been made to register "houses let in lodgings"; common lodging-houses are left to the supervision of the police. Certain of the latter houses that I visited were overcrowded, the rooms without proper ventilation, and the privy and lavatory accommodation wholly insufficient.

*School and Factory Accommodation.*—In pursuing my inquiries as to causation of various outbreaks of disease I had occasion to visit two of the public elementary schools, a private dame school, and two of the factories where numbers of young people are employed. The Castle Hall school I found unprovided with proper means of ventilation, and the atmosphere of the rooms was close and stuffy; the closets used by the children are of the most objectionable type—cesspit privies with an

overflow pipe to the sewers. The St. George's Schools are of more modern construction; and proper trough closets are provided. Here also, however, there is a deficiency of means for the introduction of fresh air into the school and class rooms; the children's greatcoats, &c., are hung up in the rooms, and from the lavatory of the infants department a drain appears to be directly connected with the public sewer. The private dame school consisted of a little ill-ventilated cottage, much overcrowded by the children received, and exposed to foul emanations from an enormous privy-midden in the yard common to this and neighbouring houses.*

In one factory privy-accommodation of a form said to be not uncommon in the district was observed. The privies are built one above the other to the number of storeys in the factory (in this case six), and communicate directly with a rough cesspool at the foot of the range. The privies open immediately from the workrooms, and all crevices to the external air are carefully stopped up. On opening the closet door from the workroom the gust of foul air that meets one, coming apparently straight from the cesspool far below, is overpowering. The workrooms are kept exceedingly close and warm (the temperature in those I visited varying from 80 to 90 F.), which renders it all the more important that the air supply should be pure.

In the second factory I visited, the closet accommodation was of a similar description—that of cesspit privies—but disconnected from the workrooms.

*Slaughter-houses.*—There are reported to be some 24 registered slaughter-houses in the district. Several of them are situated amongst the crowded yards and back places already described, so as to be unavoidably a source of nuisance.

*The Dairies, Cowsheds, and Milkshops* require to be further regulated. The Inspector of Nuisances has visited them and reported upon their structural condition, suggesting alterations that have only been very partially carried out. Hitherto no effective measures have been taken to isolate cases of infectious disease that have occurred in rooms connected with milkshops.

*Byelaws.*—Building regulations, and those relating to slaughter-houses, the removal of refuse and the like, are contained in the Stalybridge Improvement Act of 1881. The former, while containing many useful provisions, fall short of the model code issued by the Local Government Board. Especially, they allow the continued erection of large midden-privies, and they fail to prescribe all that is needed as regards the proper construction of house drains. The special ventilation of small bedrooms without fire-places has not in all cases been enforced.

*Means of dealing with Infectious Disease.*—By the Improvement Act just referred to, of 1881, medical men and householders are required to notify infectious disease. The Inspector of Nuisances has visited infected premises, supplied disinfectants, and given a printed form of instructions as to their use, and in many cases has fumigated infected houses. In the absence of a hospital, there has, however, rarely been any means of isolating a patient; while the Medical Officer of Health has not considered it his duty to make the information received under the Act the basis for systematic inquiries, nor has he considered it incumbent upon him to see that the use of "disinfectants," and of such

* When a case of typhoid fever occurred recently in one of the adjoining houses, the excreta of the patient were deposited in this midden.

precautions as under the circumstances have been possible, has been understood. Thus, even after preventable disease has broken out, conditions rendering the dwelling unwholesome, that ought to have been remedied before, have remained still undiscovered; and the so-called "disinfection," left to uninstructed or inadequately instructed persons, has often been a mere pretence.

As to hospital accommodation, the necessity of this provision has repeatedly been impressed upon the sanitary authority by the Board, and in 1886-87, in a prolonged correspondence, the advisability of combination for the purpose of the five authorities of the Ashton Union was urged upon them. The advice was, however, without result, but in 1888, during a small-pox epidemic, one of the neighbouring districts—that of Hyde—provided itself with a temporary hospital building, and Stalybridge, to a certain extent, was permitted to make use of it. Moreover, the small-pox epidemic induced the authority to take a step towards providing a hospital of their own. They bought for this purpose an isolated house, once a road-side inn, situated at the top of a hill some mile and a quarter from the town on the eastern or sparsely populated side. It is thought to convert this house, which is a roomy one, to the purposes of an administrative block, and to build the wards on a plot of land adjacent, but at a somewhat lower level. I very much fear the steep and toilsome ascent to this spot from the town will be felt as a serious inconvenience, both in respect of the removal of patients and for the necessarily frequent medical visits, and that in consequence the popularity and usefulness of the proposed institution may be impaired. Moreover, I think that an effort should still be made to combine with the neighbouring districts in the provision of a hospital. The site now chosen is situated in the opposite direction to that where a combined hospital should stand.

*Sanitary Staff.*—The Medical Officer of Health receives a salary of 80*l.* per annum, no part of which is repaid out of county funds. As already stated, systematic inquiries into reported outbreaks of disease are not made, nor are the systematic inspections, contemplated in the Board's instructions, carried out. The officer attends the monthly meetings of the sanitary committee, but his reports are practically confined to the annual statement. Copies of the latter are before the Board. For some years past it has been of a somewhat stereotyped character. The mistaken efforts of the authority to improve the privy accommodation of the town, &c., already dealt with, have not had the Medical Officer of Health's approval, or, so he informs me, been undertaken without a warning from him that the results would prove unsatisfactory. Generally speaking, I do not find that he has been able to impress on the authority the necessity of action, even where action is most required, or learn of his guiding their efforts, even when an effort has been decided upon. The optimistic tone adopted by him in his annual reports—a tone quite unwarranted by the actual sanitary conditions existing—has naturally impaired the force of any serious criticism or warning that, in a less formal way, he may have offered to the authority. The Inspector of Nuisances receives a salary of 70*l.* per annum. He is an intelligent and willing officer, but requires skilled direction and supervision in his work.

I met the sanitary committee during the progress of my inquiry, and described to them in some detail the sanitary condition of the town, and the action that was required of them for its improvement. Careful attention was promised.

## No. 11.

### On the Fatal Prevalence of Scarlatina in the First (Central) Division of the Neath Rural Sanitary District; by Mr. Spear.

The compulsory notification of the principal infectious diseases has been in operation in the Rural District of Neath since January 1st of this year (1890), so that an approximately complete list of the cases of scarlatina that have occurred since that date is available. The numbers recorded in the various months are as follows:—In January, 5; in February, 2; in March, 1; in April, 9; in May, 35; in June, 25; in July, 59; in August, 24; and in the first three weeks of September, 21. The total number reported during this period was 181, and of these 31 were fatal.

The first division of the Neath Rural District has a population now estimated at 13,300, and contains six separate hamlets. Coedfranc, with a population estimated at 4,400, is the most important of these, and the one that suffered most severely from the scarlatina prevalence. Of the total number of 181 cases reported, 81 were from Coedfranc, and of the deaths, 21 of the 31 recorded occurred in that locality. In other words, the fatality of the disease at Coedfranc exceeded 25 per cent. of the reported attacks; while in the remainder of the district the corresponding proportion was the more customary 10 per cent. The causes of the large prevalence of the disease and of its excessive fatality at Coedfranc, were two special points in the inquiry.

At Coedfranc the outbreak in the spring and summer of the present year appears to have been the climax of a long continued prevalence. In July 1889 the Medical Officer of Health reported "scarlatina is "still hovering about;" in August, "there have been a few cases of "scarlatina, but the disease has not broken out into any activity;" in October, "scarlatina is a little more prevalent;" in December, seven cases were reported. In all, during 1889, five deaths from the disease were registered at Coedfranc.

The compulsory notification of infectious disease has not been accompanied by any efficient action for preventing the spread of infection in the district. In effect, the notification certificates received were simply filed. The Medical Officer of Health has visited houses from which fatal attacks were reported, but not upon receiving information of infectious sickness. On occasions chloride of lime has been given by the Sanitary Authority to infected households, but the use of disinfectants has not been systematically, or as a rule, enforced. For example, in October 1889, two children suffered from scarlatina in a house at Springfield, Coedfranc, and one died. The Medical Officer of Health visited the house, but no disinfectants were used, nor was any lime-washing or re-papering, or other special cleansing of the rooms carried out. The disease again made its appearance in the same family in January of the present year, and another child died, and again no measures of disinfection were taken.

The Medical Officer of Health has frequently advised the Authority to provide an isolation hospital, but his advice has not been followed. He has frequently reported that isolation was impossible in the cottages of the poor.

One of the schools at Coedfranc was closed during the scarlatina prevalence in the summer of 1889, but nothing of the sort was attempted at Coedfranc during the far more serious prevalence of 1890. There

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On Scarlatina in Central Division of Neath R.S.D.; by Mr. Spear.

is little doubt that school attendance played a considerable part in the dissemination of infection. The mistress of the Abbey Infant School gave me to understand, for example, that on four different occasions she found children attending school whose skin was in a state of active desquamation after scarlatina. As a matter of fact, the school suffered from the disease to a greater degree than other schools. Amongst the 150 children, or thereabouts, who habitually attend the school 34 suffered from scarlatina between May and September. At one time, the mistress informs me, 10 children were absent from this cause from one class alone. Of the 34 sufferers, 6 died.*

From such clinical histories as I could obtain there did not appear to be in the type of the disease any noteworthy departure from common experience. In a certain number of the fatal cases death occurred early, but in 30 per cent. it was ascribed to nephritis following the acute stage. The fatality was almost as great during the summer as in the spring months; 18 deaths occurred during June, July, and August, and half of these during the last-named month. The two sexes suffered from fatal attacks almost equally. One infant, under one year, died; the remaining deaths were amongst children between two and ten years of age.

I have already noted the fact that the disease was more fatal at Coedfranc than in the other hamlets of the district, and I find that an observation of similar purport has been recorded by the Medical Officer of Health respecting earlier experiences in his district. In his report for the year 1889, he says:—"The population of the hamlets (including "Coedfranc) on the west side of the River Neath amounts to 9,017, "while that of Llantwit amounts to 4,138, or not quite half; whereas the "proportion of deaths is as three on the west side to one on the east "side of the river, and those from zymotic diseases were 21 on the "west side and two on the east side." His tables for that year further show that of the 21 deaths from zymotic disease, 13 occurred at Coedfranc, five of these being from enteric fever. Commenting upon the above-quoted obervation, he says:—"It would appear that this "great disproportion is owing to the fact that a thorough system of "drainage has been carried out on the east side, while nothing of the "kind has been effected on the west." The subject matter of my inquiry demanded, it was evident, some particular attention to the sanitary condition of Coedfranc.

### *Sanitary Circumstances.*

Coedfranc is a populous village, or rather a series of connected villages, extending for a mile or more along the highway between Neath and Swansea. It is built chiefly on the slope of a hill so that the natural facilities for main drainage are considerable, although hitherto no public sewers have been provided. The houses near the highway are drained, very often by roughly constructed channels which pass frequently beneath the houses, to the roadside gutter, where the sewage causes, at various points, considerable nuisance; those in the side streets, or further removed, not possessing even such facilities as the roadside gutter affords, are even more unsatisfactorily circumstanced. Sewage accumulates in pools or ditches about the houses, as at "The Abbey"; or, as is chiefly the case with the newer property, is discharged

* The summer school holidays lasted from about the end of July to about the end of August—at the Abbey School from July 25th to August 25th—and it may be remarked that during August the number of cases reported notably diminished.

into leaking and unventilated cesspools or "dumb wells." One collection of houses near the railway station at Dynevor had, I found, been drained after a certain fashion; the drain in places was partly above the ground level, it was provided with catch-pits in its course, it was unventilated, and it discharged on to the railway embankment in such a way as to occasion nuisance to the passers-by.

Excrement disposal is generally by old-fashioned privy-pits. These often contain an accumulation of twelve months or more; are dilapidated and foul. A very few of the newer houses have been provided with small box-closets, but no public provision is made for the emptying, and they, too, accordingly, are allowed to overflow, and become a nuisance. The removal of ashes and house-refuse is effected by the Authority under a contract.

The water supply of some five-sixths of Coedfranc is obtained from the mains of the Neath Water Company, the source being the Darran Springs, a different one from that which supplies the town of Neath. The company have apparently little means of storage, and the yield of the spring is reported to be insufficient for the requirements of the population. In dry summers there is evidently considerable scarcity of water; even in ordinary seasons the inhabitants complain that the service is often discontinued. The insufficiency of the supply has been the subject of remonstrance by the Authority to the water company, and it has doubtless stood in the way of a much-needed extension of a general service. Of the remaining sixth, many are greatly in need of wholesome water. The inhabitants of certain cottages at the Abbey told me that they had to fetch water from a spring nearly half-a-mile away. At Burrows Road, where a serious outbreak of enteric fever occurred last year, the people have to resort to a surface spring obviously much liable to chance pollution. Some 100 houses in various parts are supplied from surface wells often sunk in close proximity to defective drains and the like. It is stated that the company's water, in times of scarcity, becomes discoloured and unpleasant. On the whole, the water supply of the village must be regarded as exceedingly defective and unsatisfactory.

The houses of Coedfranc are, in many instances, rendered unwholesome by the defective drainage arrangements to which I have referred, and by the unpaved and sewage-sodden state of their surroundings; and, apart from this, there are a certain number which are unfit for habitation, from inherent defects of structure, from their dampness, their dilapidation, and the want of proper means of ventilation. Overcrowding, too, is occasionally met with. In a place known as "Under the leat," for example, I found a woman and four children were living and sleeping in one apartment of little more capacity than 1,000 cubic feet. There was a loft above, but the water came in in such a way that it could not be used. The room actually occupied was excessively damp, with a mud floor sunk beneath the ground level, and possessed of no through ventilation. A neighbouring family I found occupying, both for living and sleeping purposes, a similar habitation. It was said that, in wet weather, sewage from neighbouring premises and storm water had welled up through the dilapidated floor and formed a foul pool beneath the beds. But, for domestic use, the people here have no convenient supply of water, and obviously a quite insufficient amount is used for purposes of household cleanliness. In each of these habitations a child had recently died from scarlatina.

I visited the schools of the district, and found certain improvements needed in their sanitary condition. Bad cesspit privies are in use in connexion with all of them. The Skewen (Coedfranc) National Infant

School is at times overcrowded, and, more especially the class-room, is inadequately ventilated. As regards ventilation, more care generally is required to maintain air inlets and outlets free from the obstruction of accumulated dust.

The dairies and milkshops of the district are said all to be registered, but judging from what I saw of one at Coedfranc, it is clear that more effective regulation is required. This cowshed was dirty, dilapidated, and unventilated, with drainage and pig-stye nuisances about it, and the milk was strained and otherwise dealt with in the living room (and this not a clean one) of the family. I found no evidence of any association between the milk supply of the district and the scarlatina prevalence.

Dr. Russell, the Medical Officer of Health of the central district, has just resigned. The Inspector of Nuisances requires the supervision, direction, and assistance of a skilled officer. Hitherto this has not been given, there having been little official communication between him and the Medical Officer of Health.

I conferred with the Sanitary Authority on September 23rd, at a special meeting called for the purpose. Resolutions were then adopted as follows :—

1. "That the Surveyor report upon the drainage of Skewen (Coedfranc) and Neath Abbey."
2. "That the Surveyor report as to houses unfit for habitation."
3. "That the Clerk report as to the position the Authority now occupy with the Neath Water Company—as to what has already taken place, and as to what powers the Authority possess."

I described also the means that should be adopted by the Authority for controlling spreading disease, and for utilising the information received under their system of notification of infectious cases. The fact that they are now practically without the services of a Medical Officer of Health was felt naturally to be a difficulty in the way of establishing immediately such an organization as is here wanted. The appointment of a new Medical Officer of Health will be immediately proceeded with.

Probably the provision for isolating the infected sick of Coedfranc might advantageously be made by a hospital that could be used in conjunction with the Sanitary Authority of the Neath Urban District.

No. 12.



## On an Epidemic of Pneumonia at Scotter, Lincolnshire, and in the neighbouring places; by Dr. Parsons.



Circumstances of inquiry.

On May 16th, 1890, the Local Government Board received from Mr. Franklin Eminson, surgeon, of Scotter, in the Gainsborough Rural Sanitary District, information of a very serious and fatal epidemic of a disease described as pleuro-pneumonia, which had been present in that village for over a month. A report on the epidemic having been asked for and made by Mr. H. Wright, Medical Officer of Health for the district, in which an opinion as to its causation was expressed differing from that held by Mr. Eminson, the Rural Sanitary Authority, on June 17th, passed a resolution asking the Local Government Board to cause a local medical inquiry to be made, with a view of ascertaining the origin and cause of the outbreak, and suggesting any necessary steps to prevent its extension. In compliance with this request I received on July 2nd instructions to visit the district and confer with the Sanitary Authority and its officers, and my inspection, which was made as soon as prior engagements permitted, was commenced on July 9th and concluded on July 18th.

On my arrival I found that cases of the disease in question had occurred not only at Scotter, but also at Scotton, a mile distant, in the Gainsborough Rural District, and at Messingham, two miles distant, in the Glanford Brigg Rural Sanitary District. I therefore sought and obtained authority to extend my inquiry to the latter district.

Scotter: General description.

The parish of Scotter contained in 1881, 247 inhabited houses and a population of 1,070; it comprises the village of Scotter, estimated to contain between 700 and 800 inhabitants, and several outlying hamlets and farms. The situation of the village is sheltered; it is placed at the point where a low ridge running north and south, formed by the escarpment of the lower lias limestone (here so loose and rubbly as to be locally called "gravel,") is cut through by a small stream, called the River Eau. Westward a tract of low-lying land intervenes between this ridge and the River Trent, three miles distant, and three miles to the eastward is a parallel higher ridge, the Cliff. About a mile south of Scotter is a wide tract of sandy heath, Scotter Common, recently enclosed, but not yet entirely brought into cultivation. The village of Scotter, of which a map is annexed,* consists mainly of a single street, more than half a mile in length, with a general direction from S.E. to N.W., nearly parallel to the River Eau, about 200 yards to the N.E. The street is curved, so that in relation to the centre one end is south and the other end west. The ground falls from an altitude of 56 feet at the south end of the village to one of 25 feet in the centre, the part of the street westward from this being level. The houses form more or less continuous rows on both sides of the main street, they also extend for a short distance along two roads leading out of it in the centre of the village towards Gainsborough on one hand and Messingham on the other, and there are other houses in a back lane, called "The Sands," parallel to the main street.

The houses have, with few exceptions, plenty of open space at the back. There are a few old cottages, of which the bedrooms are of cramped dimensions and ill-ventilated. The inhabitants are of the agricultural class.

Sewers and drains.

The village is sewered in sections. One sewer extends from the southern end of the village to the centre, and then turning down a side road discharges into the River Eau. This sewer has a good fall; it is

* Not here reproduced.

constructed of 9-inch socket pipes, with unluted but tolerably close-fitting joints. It is said to have been constructed by the highway authority for the drainage of the road; but, besides surface water it receives house slops and the drainage of farmyards, and also at the upper end excreta from a w.c. at the rectory. I saw it opened in two places, where it was clean and free from sediment; but I was informed that at one point sediment to a depth of an inch or two had been found in it. A branch of this sewer, which I saw opened at the back of a row of houses on the S.E. side of the Green, was choked with black sediment. No special means of flushing or of ventilation have been provided for any of the sewers.

The western end of the village street is drained (according to a map prepared for me by Mr. Wm. Eyre, Inspector of Nuisances to the Gainsborough Rural Sanitary Authority) by two sewers, which discharge into the "parish ditch," a watercourse which finds its way into the River Eau. Comparatively few of the houses at this end of the village are connected with the public sewers, those on the north side of the road draining separately, or two or three by a joint outfall, direct into the "parish ditch." The house drains in this part of the village are of very rough construction, being made of field tiles, or of brick, with rough untrapped inlets. Some of the inlets are large square brick catchpits, locally called "cesspools"; others are furnished with cast-iron "D traps," generally loose and non-efficient. The house drains in the south end of the village are described as having been formerly of similar character (some seen were so still), but considerable improvements have been effected by the Sanitary Authority in the drainage of this portion of the village since the occurrence of the epidemic, and many of the old inlets have been replaced by earthenware trapped gullies. The inlets are usually at some little distance from the houses; in only one instance in Scotter was one found indoors; this was in the workshop occupied by a man who had died of pneumonia.

Privies.

The privies in Scotter are in connexion either with ashpits, open or covered, or with underground vaults. Privy nuisances were noticed in some instances, but as a general rule the privy is a good distance from the house. Foul farm yards and collections of manure were noticed in some instances close to the houses.

Water supply.

The water supply is obtained from shallow wells; in the lower part of the village the water level is not more than two or three feet below the surface. The wells are steined only with loose masonry, and many of them are near to privies, farmyards, leaky drains, and such like sources of contamination. I did not, however, hear many complaints of the quality of the water. It is believed that there is a constant flow of underground water through the porous subsoil from Scotter Common towards the Eau, which would tend to dilute and carry away impurities soaking into the subsoil. The occurrence, however, of cases of enteric fever in Scotter almost every year, and of severe epidemics of that disease in the years 1858 and 1868, points to danger from the water supply.

Previous prevalence of disease; enteric fever.

Erysipelas.

Erysipelas has always been common in Scotter; cases, more or fewer, occur every year, and in 1885 there was an epidemic which necessitated the postponement of the customary periodical vaccinations in April.

Pneumonia in 1886.

A prevalence of pneumonia occurred in Scotter in the spring of the year 1886, when there were nine cases, one of them being fatal. The majority of the cases were in one part of the village, the western end. Two of the cases occurred in one house. Of several of the houses in which these cases happened the sanitary surroundings are remembered to have been bad, and there have since been in the same houses other cases of illness likely to have been caused by bad sanitary conditions.

Recent outbreak: Extent.

The disease which attracted attention at Scotter seems to have commenced there about the beginning of April 1890. During the first three months of the year there occurred in Scotter five deaths from all causes (the mortality being at the rate of 18·7 per 1,000 inhabitants per annum). During the three months April to June, 14 deaths occurred; the deaths corresponding to an annual rate of 52·5 per 1,000 inhabitants. Of the 14 deaths 12 are believed to have been caused by the disease in question, although not in all cases so certified (*see* table, Addendum B.).

For information as to the extent of the epidemic, and respecting the clinical characters of the disease, I am chiefly indebted to Mr. Franklin Eminson, under whose care most of the later cases have come. The earliest cases in Scotter were attended by his father, the late Mr. Robert Eminson, of Scotter, who himself died a victim to the disease on June 8th. Among the cases reckoned as of the disease in question are those of two persons over 80 years of age, of whom the certified cause of death was "old age," and "old age, diarrhœa," respectively, and a third in which, a good deal of delirium being present, the cause of death was certified as "cerebral congestion." It was, I am told, the usual custom of Mr. Eminson, senior, to certify "old age" as the cause of death in persons over 80 years old, but his son tells me that his father in conversation with him fully recognised these cases as being of one and the same specific disease, which he called "Typhoid pneumonia."

Clinical characters.

The clinical characters of the pneumonia as observed at Scotter and neighbourhood have been as follows:—

The length of the period of incubation is doubtful, but it appears to be short, from a few hours to two days (assuming the disease to have been contracted at the time and in the manner locally supposed).

The invasion was generally sudden, often in the night, with usually rigor and vomiting, sometimes diarrhœa, pain in chest or region of liver, or headache, and a feeling of faintness and prostration, and sometimes drowsiness.

A high state of fever was rapidly developed: in several cases Mr. F. Eminson found a temperature exceeding 104° F. at his first visit; the subsequent course of the temperature was, however, very irregular, it being not unfrequently higher in the morning than in the evening, contrary to the usual course in febrile diseases.

Signs of inflammatory mischief in the lungs were found more or less in every case, but sometimes did not make themselves evident for several days after the first symptoms of illness. There was evidence of pneumonic consolidation of portions of lung of greater or less extent; also in many cases pleuritic friction sounds, and in other cases (especially in persons subject to bronchitis) moist *râles* and other bronchitic sounds.

Cough and difficulty of breathing were not usually prominent symptoms; and the respiratory movements were often not quickened in greater proportion than the pulse; the normal ratio of frequency of 1 to 4 being little departed from. The sputa varied; in some cases little or nothing was raised; in others the sputum was rusty or blood-streaked; in others again, in which bronchitis was present, it became profuse and yellow. The pulse was accelerated, sometimes full and bounding at first, rapid and small in the later stages.

Headache was often present, and in some cases delirium of a noisy and busy character; the patient being talkative, and constantly wanting to get out of bed.

Bleeding from the nose occurred in several cases, and was copious in one of them.

Gastro-intestinal symptoms were generally present. Vomiting as an initial symptom was, Mr. F. Eminson says, quite as frequent as rigor, and it sometimes persisted throughout the case. In one patient, a strong and healthy man in the prime of life, uncontrollable vomiting brought about a fatal issue. Diarrhœa also occurred in some cases.

The course of the disease was short, generally under a week in fatal cases, though in one it lasted a month. In one or two cases a relapse occurred, and was found to be associated with the extension of pneumonic mischief to the other lung.

No post-mortem examinations were made.

The fatality of the disease in pronounced cases was very great; of 29 cases which had occurred up to the time of my visit, 18 or 62 per cent. died.*

This description of the disease rests, as I have said, upon the authority of Mr. Franklin Eminson, supplemented by the statements of patients and surviving friends. Mr. Eminson is a careful observer, and he has kept notes of the cases attended by him, and has kindly furnished me with clinical histories of some of them (*see* Addendum C.). I had little opportunity of observing the clinical characters of the disease, as at the time of my visit the outbreak was almost over, only three cases remaining under treatment. One of these was convalescent; in the other two the temperature had fallen to normal, but signs of consolidation remained in the lung. I cannot say that in their then stages the cases differed in any evident feature from ordinary cases of pneumonia.

Besides the Messrs. Eminson, father and son, few of the medical men in the neighbourhood had up to the time of my visit had cases of the kind under their care. One of the reputed cases at Messingham was attended by Mr. George, of Kirton Lindsey, who informs me that he only saw the patient once shortly before death, and that the symptoms were those of bronchitis; I have, therefore, excluded this case from the list. Mr. Behrendt, of Burringham, in whose district as poor law medical officer Messingham is situated, writes: "I had only one case "such as Mr. Eminson saw a number of, and it seemed to me to differ "but little from typical cases of acute croupous pneumonia. What "struck me most was the moderate severity in symptoms as contrasted "with the termination, which was fatal."

Feeding experiments.

At the suggestion of Dr. Ballard, some tame mice were fed by Mr. Eminson with bread soaked in the sputa of some of the later cases, and in several instances with fatal results. Two mice fed on the fourth day of the disease with the sputa of a case which proved fatal (J. C. of Scotton) died in 30 hours. Those fed on the sixth day of the disease on the sputa of a case which recovered (J. N. of Scotter) became ill in 24 hours; they were very quiet, and their coats stood on end. They gradually recovered until they seemed almost well, except that their bellies were larger than normal, and their noses looked pinched. On the morning of the eighth day after commencement of experimental feeding, they were found to have eaten up the whole of the soaked bread given them the previous day; in the evening they were very ill, and next morning were dead. One mouse was fed in the afternoon of June 24th with sputum from another case (G. V. of

* Including later cases the figures stand thus—Cases 32, deaths 22: mortality 69 per cent.

Scotter, taken ill on June 21st) : its coat was staring on June 26th, and it died on the afternoon of June 28th.

Mice fed with the sputa of two of the Messingham cases remained apparently unaffected.

The bodies of the mice which died were sent to Dr. Klein for examination, but those from J. N.'s case were unfortunately rendered useless by a delay in the post. In the others, both lungs were found extremely congested,* and from the lungs Dr. Klein obtained in pure culture a bacillus identical with that found in the Middlesbrough pneumonia cases reported on by Dr. Ballard. (Annual Report of the Medical Officer to the Local Government Board for 1888.)

This observation seems to establish the identity of the disease at Scotter and neighbourhood with that investigated at Middlesbrough by Dr. Ballard, and called by him "pleuro-pneumonic fever." The general character of the disease, and its great fatality—greater in proportion in the Scotter cases even than at Middlesbrough—point to the same conclusion. As I shall have to mention later, the fatal and formidable pneumonia cases at Scotter occurred in old persons and in adults, chiefly males, in the prime of life, but they were preceded and accompanied by a prevalence, especially among children, of a malady manifesting itself by diarrhœa and vomiting, and which there is reason to suppose to have been of the same essential nature.

History of earlier cases

The first case of the pneumonic disease in Scotter is believed to have been that of James Barker, aged 82; a hale old man, who lived alone in a house on the south side of the Green, and had been at work in his garden the day before his illness. On the morning of Easter Sunday, April 6th, his neighbours, alarmed at his non-appearance, summoned a relative, who, getting up to the bedroom window by the aid of a ladder, found the old man lying on the floor. He rose to let him in, but staggered and seemed very ill. Little information was forthcoming respecting his illness, as he was under the care of the late Mr. Eminson, senior. He is said to have had no cough, and but little expectoration; he breathed hard towards the end of his illness. He did not wander or talk much. According to one neighbour he had no sickness or diarrhœa, but according to others there was diarrhœa. He sank and died on April 10th, the cause of death being certified as "old age." He had not been out of Scotter for some years, but walked about the village every day. No cause can be assigned for his illness, such as a chill or exposure to introduced infection. The house in which he lived has an open space at the back; the drain inlet, 27 feet from the back-door, was untrapped, and the drain blocked with sediment; the pump is close to it.

A man, aged 80, had died in the next house—a roadway and yard intervening—on January 27th of "old age," but there is no evidence that this man's illness was of the same nature as Barker's illness.

Several of the persons who attended to Barker in his illness, or handled his things after his death, suffered from what is believed to have been the same disease, and appeared at first sight to have communicated it to others. But with regard to almost all of these it has to be stated that they lived—or in one case had lived up to four days before the illness—in the same quarter of the village, and in proximity

* Of the mice from J. C.'s cases, Dr. Klein says, "In both animals both lungs "were intensely congested, dark purple in colour, and parts of the lungs red-"hepatized." Of that from G. V.'s case he says, "both lungs were found deeply "congested in their entirety."

to one particular sewer. The facts about these groups of cases are as follows:—

Group I. Mrs. Vickers, 48, who sat up one night with Barker, laid him out after death on April 10th, and washed some of his clothes on the following day, was taken ill at 10 o'clock on the evening of April 11th with shivering, nausea, and aching pains all over. On April 13th, 1 p.m., her temperature was 103·5, there was considerable depression, and the breathing was accelerated; a few rhonchi were heard in the lungs, but there were no signs of consolidation. The sputum is described as like "blood and corruption." On April 14th her temperature had fallen to 99, and next day it was normal, but she kept her bed a week. Two of her children were unwell about the same time, one a few days before, the other a few days after their mother, but the nature of their illness cannot be certainly stated. The drain inlet which serves this house is out of doors and 15 feet from the house, and is furnished with a good gully trap which was put in last winter, some months before Mrs. Vickers's illness. A nuisance from a collection of manure next door is stated to have existed at the time of the illness.

An old woman, Martha Hiles, 84, living next door to Mrs. Vickers, and who had conversed with her on the evening of April 11th, was found at 10 a.m. on April 12th lying on the floor very ill, having got out of bed and fallen. She died next day; the cause of death being certified by Mr. Eminson, senior, as "old age, diarrhœa." The symptoms of her illness, I am told, were feverishness, inability to swallow, sore throat, the throat being red and inflamed inside, a rattling in the throat, and diarrhœa, but no vomiting. Mr. F. Eminson tells me that his father considered the case to be one of the same nature as the others. Another woman, who attended to Mrs. Hiles during her illness, was taken ill on April 13th with shivering, loss of appetite, pain in the chest, cough and expectoration of yellow, not red, mucus; she had sore throat and vomiting with the cough but no diarrhœa; she was in bed a fortnight. She had never thoroughly recovered from influenza which she had had in the winter, and is now stated to be in an advanced stage of phthisis. It cannot, therefore, be affirmed that her illness was of the same nature as the others.

[If Mrs. Vickers contracted her illness from Barker, Mrs. Hiles from her, and the other neighbour (if her illness were of the same kind) from Mrs. Hiles, the period of incubation of the disease must be very short, and its infective stage very soon developed. The disease also on this supposition showed itself to be more infectious in this group of cases than was experienced in other instances. There is some suggestion that cases in which diarrhœa was a symptom were more likely to become sources of infection than others in which this condition was absent.]

Group II. A man named Fieldston with his family resided next door to Barker up to April 9th, when they removed to another part of the village, The Sands. On April 12th, however, he was at Barker's funeral, and helped carry him to the grave. He had not been into Barker's house before.

On April 13th, at 7 p.m., Fieldston was taken ill with shivering and pain all over, especially across the chest. He had pain in drawing his breath, and free blood-streaked expectoration. He was ill six weeks but recovered. Two of his children had been ill with vomiting and diarrhœa the week before his illness began. His mother-in-law, Mrs. Foster, residing near the south end of Scotter, who came to see him during his illness, was taken ill on April 23rd, and died on April 26th, the cause of death being certified as "acute broncho-pneumonia."

Her neighbour, Mrs. Hutson, a hale old woman of 82, who had helped to lay her out and had helped to wash her clothes after the funeral, was taken ill on May 12th, and died on May 17th, the cause of death being certified as "pleuro-pneumonic fever 5 days."

Group III. Mrs. Chantry, 63, had nursed Barker, and sat up with him when ill; she had also helped in the "flitting" after his death, and had on April 23rd washed some blankets, &c., soiled by him in his illness. She was poorly on the night of April 24th, and though she got up next morning had to go to bed again. She was "hot and cold," unable to walk, had pain in the chest and could hardly talk. During her illness she is said to have been very hot and to have had pain in the left side, bringing up reddish mucus; she had also pain in the head, and was delirious more or less throughout her illness, but especially on one night. She died on April 30th, the cause of death being certified as "cerebral congestion." During her illness she was attended to in part by her son, 33, living at Susworth, a hamlet three miles west of Scotter, who used after his work to walk to Scotter, and sit up by night with his mother. His children had a month or two before been ill with scarlet fever and diphtheria, and he himself had had "quinsy," but had recovered. On May 1st he came home from work shaking with cold, sick, and purged, and he died on May 5th, the cause of death being certified as "epidemic pneumonia 4 days, bronchitis." (*See* case 2 in Addendum C.)

In the other cases no history of direct connexion with a previous case was made out except in that of Mr. Eminson, senior, who believed that he contracted the disease in attending on a patient in whose case there was profuse diarrhœa, and who lay in a small close room of which the atmosphere was quite unbearable. Mr. E. felt nauseated by the smell, and was taken ill next day.

In only one instance did more than a single case of recognised pneumonia occur in a house, but in several of the invaded households there were about the same time, either shortly before or shortly after, cases of indisposition among the other members of the family, especially children of school-going age. These attacks were manifested by some of the following symptoms, viz., vomiting and diarrhœa, pallor, headache, and feverishness.

Prevalent illness among children.

I learn from Mr. Allen, master of the Scotter National School, that such attacks were very common among the school children in the latter part of March and in April. I took down from the school register the names of 17 children who were absent from school for a week and more on account of illness, and Mr. Allen says that there were others who were not sent home, but allowed to remain in school and excused lessons. All these children he thinks had the same complaint, which he thought at the time was a return of influenza.* They were pale and languid, and had headache; some were sick and some purged.

An illness of this kind seems to have been general in Scotter in the spring of this year; a history of such cases was to be elicited by close questioning in many households; but often their occurrence had been forgotten and was at first denied.

Mr. Franklin Eminson states that several cases of vomiting and lung congestion without pneumonia and without rigors occurred in adults at the same time.

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* Influenza was prevalent in Scotter in January, and had practically ceased by the time that the present disease occurred. Some of the pneumonia patients had suffered from influenza in the winter, others had not.

There seems, however, to have been no prevalence of any complaint similar to that among the children at Scotter in either Scotton or Messingham, villages in which cases of pneumonia occurred.

Pneumonia at Scotton

At Scotton (population 260), a village a mile south of Scotter, three cases of pneumonia occurred, commencing respectively on May 3rd, May 10th, and June 19th. Two of the patients were adult men, both of whom died; the third, a child, recovered. No connexion between the cases was ascertained, and in the last case only had there been any recent communication with Scotter. At all the houses defective drains existed, and in one there was gross overcrowding with defective ventilation of the bedrooms; but the disease did not spread in spite of these conditions. The sewers in Scotton are defective, being constructed of 6-inch horseshoe tiles, with flat earthen bottoms; and being provided with cesspools in their course "to catch the sediment."

The question of the better sewering of Scotton was under consideration by the Rural Sanitary Authority at the time of my visit.

and Messingham.

Messingham (population 1,132) is situated two miles north of Scotter, on the low ridge of lias before mentioned. The inhabitants are partly engaged in agriculture, but there are among them a good many who are employed at the iron furnaces and ironstone pits at Scunthorpe, five miles further north, and who go to their work and back in breaks, daily. Messingham is provided with pipe sewers, which are said to be in good working order, but they are deficient in means of flushing and of ventilation, and some of the street inlets are untrapped. Some of the cottages, however, drain into cesspools.

In Messingham six or seven cases of pneumonia had occurred up to the time of my visit; one of the cases, as before mentioned, being doubtful. These occurred in two batches, the first two on May 31st and June 1st, the others at the end of June and beginning of July. No history of recent communication with Scotter was in any case ascertained. The patients lived in different parts of the village. The first patient was an agricultural labourer; the second, an ironstone miner, was attacked the day after the first. One of the patients had been two days before her attack to see one of the others, living in the same street, who was a relative of hers, and was then lying ill of pneumonia. Another had sat with a mate, who was one of the first victims, and after his death had helped to lay out the body: but this was on June 8th, and he was not taken ill till July 5th. In two cases there was a history of recent exposure to cold and wet. I did not hear of any concurrent cases of other illness, but in one household there has since been a fatal case of scarlet fever.

Extent and incidence of epidemic.

The extent of the outbreak in the three parishes cannot be stated with certainty as there is difficulty in deciding whether particular cases should or should not be counted, but guided mainly by the opinion of Mr. Franklin Eminson, I reckon the number of cases with definite pneumonic symptoms as about 29. If the cases with symptoms of gastro-intestinal disturbance and pulmonary congestion which occurred about the same time were of the same essential nature, the above number would have to be increased to a considerable undetermined extent. On the other hand, it is possible that some of the cases included above may have been of non-specific lung inflammation. (The failure to infect mice with the sputa of two of the Messingham cases is consistent with this.)

The 29 cases of pneumonia have been thus distributed in time and locality; the dates given being those of the commencement of the several cases, which, owing to the sudden invasion of the disease, could almost always be definitely fixed.

| Locality. | Weeks ending | | | | | | | | | | | | | Total. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | April | | | May | | | | | June | | | | July | |
| | 12. | 19. | 26. | 3. | 10. | 17. | 24. | 31. | 7. | 14. | 21. | 28. | 5. | |
| Scotter Village - - - | 3 | 1 | 6 | 2 | 1 | 1 | — | — | — | 1 | 1 | — | — | 16 |
| Outlying places in Scotter Parish. | 1 | — | 1* | 1 | — | — | 1 | — | — | — | — | — | — | 4 |
| Scotton - - - - | — | — | — | 1 | 1 | — | 1 | — | — | — | — | — | — | 3 |
| Messingham - - - | — | — | — | — | — | — | — | 1 | 1 | — | — | 1 | 3 | 6 |
| Total - - | 4 | 1 | 7 | 4 | 2 | 1 | 2 | 1 | 1 | 1 | 1 | 1 | 3 | 29 |

* Secondary case.

The cases occurred in 28 households; in one only did more than one case of recognised pneumonia occur, though, as before mentioned, there was concurrent sickness in several.

The following particulars relate to 24 of the households:—

| | | |
|---|---|---|
| Total number of inmates - - - | 97 | |
| Cases of "pneumonia" - - - | 25 | 43 |
| Other concurrent illness - - - | 18 | |
| Inmates who remained well - - | 54 | |
| | 97 | |

In five of the households the patient was an old person living alone.

Of the 29 cases of pneumonia, 18, or 62 per cent., were fatal. (At Middlesbrough the percentage of attacks at all ages that proved fatal in the practice of 11 medical men during the epidemic period in 1888 is given by Dr. Ballard as 21·1; the higher mortality at Scotter is perhaps to be ascribed partly to the large proportion of old persons attacked.)

The following table shows the number of cases and deaths at different ages:—

| — | Age. | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | –1. | 1–5. | 5–15. | 15–25. | 25–35. | 35–45. | 45–55. | 55–65. | 65–75. | 75+. | Total. |
| Cases - - - | — | 1 | 2 | — | 2 | 5 | 3 | 6 | 3 | 7 | 29 |
| Deaths - - - | — | — | — | — | 2 | 2 | 1 | 5 | 1 | 7 | 18 |

The higher mortality at the later ages is better shown by arranging the cases in larger age-groups, thus—

| — | Cases. | Deaths. | Per cent. of Attacks fatal. |
|---|---|---|---|
| Under 30 - - | 3 | — | — |
| 30–60 - - | 14 | 8 | 57 |
| 60 and above - | 12 | 10 | 84 |
| Total - | 29 | 18 | 62 |

App. A. No. 12.

On Epidemic Pneumonia at Scotter, &c.; by Dr. Parsons.

Of the 29 cases, 18 with 12 deaths (or 67 per cent.) were in males, and 11 with 6 deaths (or 54·5 per cent.) in females.

Of the patients in the prime of life who died, some were, before the attack, in weak health; thus, one was a woman whose confinement was brought on by her illness, and another had lately recovered from an attack of "quinsy;" others, however, who died were strong and healthy men, while two patients of intemperate habits recovered.

Etiology.

The account that has been given of the characters and behaviour of the recent "pneumonia" in Scotter and neighbourhood seems to show that we are dealing with a specific febrile disease, marked, but perhaps not necessarily, by an inflammatory affection of the lung as one of its local manifestations. The essential cause of the disease would appear to be a bacillus, not distinguishable from that found in the Middlesbrough epidemic. The mode of propagation of the disease may therefore depend upon the way in which the bacillus makes its entrance and effects a lodgment in the human system.

Respecting this pneumonia two different views were propounded by local medical men. The Medical Officer of Health, Mr. H. Wright, at first ascribed the disease to the recent inclement and variable weather, and afterwards considered it to be propagated by direct infection from person to person. Mr. Franklin Eminson, on the other hand, maintained the view that the disease was directly infectious only in a slight degree, but was propagated mainly through the medium of infected sewers and drains of defective construction, or of other nuisances, such as polluted and infected soil.

That the prevalence of pneumonia at Scotter is not to be sufficiently explained by weather conditions is evident from the fact that it has been confined to that and the neighbouring villages, the remainder of the Rural Sanitary District having suffered no such prevalence. In Addendum A. are given the deaths ascribed to pneumonia which have occurred in the other villages of the district (with an aggregate population of 16,749) in the first half of 1890. They are only 13 in number; in several of them the pneumonia was secondary to other diseases, and in few villages did more than one death occur. Scotter stands in a sheltered situation, and in the part in which most of the pneumonia cases have occurred, the subsoil is dry. There is no apparent reason why it should be especially affected by the weather.

By way of clearing the ground, the influence of certain other conditions capable of acting as carriers of disease may in the present case be excluded.

Water was in almost every case obtained from a different source, though some of the sources might be liable to contamination.

Milk, too, was obtained from many different sources, and several of the patients were not in the habit of using milk prior to their illness.

Bacon, manufactured in a particular way, was considered by Dr. Ballard to have been one of the means whereby the infection was propagated at Middlesbrough. I find, however, that at Scotter the bacon used was, as a rule, fed and cured at home by the parties themselves. No prevalent disease among domestic animals was heard of.

With a piece of bacon obtained by me on July 11th from the house of J. C., of Scotton, who had died on July 1st (Case 4 in Addendum C.), mice were fed by Dr. Klein, but they remained well.

(?) Contagion mediate or immediate.

The arguments in favour of the propagation of the disease (the pneumonia), as a rule, by indirect infection through drain effluvia, rather than directly from person to person, are summed up by Mr. Franklin Eminson in the following statement:—

"1. The history of the causation and beginning of the epidemic :—

"(*a.*) Its origin was local, it began in Scotter, there being no unusual pneumonia elsewhere in the district (only one fatal case in the first six months of the year in the Scotter Registration Sub-district, excluding Scotter and Scotton).

"(*b.*) Its spread has been from Scotter as a centre to the nearest places and the places in most constant communication with it, viz., to Scotton first, and then Messingham.

"It has not reached Kirton, Northorpe, Laughton, nor Blyton, all neighbouring places, but with little inter-communication.

"The Messingham cases have been nearly two months subsequent to the outbreak in Scotter, the Scotton cases nearly one month subsequent.

"(*c.*) Not only was the outbreak peculiar to Scotter in its beginning, but it was peculiar to one particular part of Scotter, viz., to that part drained by the main sewer ; for even now after the disease has had time to extend, one in every six or seven houses drained by this particular sewer has had a case of the disease, while only one house in 32 of those not so drained has had the disease present in it.

"Again, not only was the disease peculiar to Scotter and to that part of Scotter drained by the main sewer, but it was specially peculiar to those houses standing close to the sewer, for these had one case in every 4, while all the rest had one case in about 28.

"(*d.*) It is admitted that the rain-water inlets in the streets were all defective except one, allowing the escape of gas, and it is known that a bad smell was very commonly perceived from some of them.

"And it is admitted that when the yard inlets of the drain attached to the houses were trapped at all, those traps were (except at the rectory) mostly defective and inefficient, and it has been seen that *even now*, after extensive improvements have been effected subsequent to the epidemic, many untrapped and rude inlets into the drains still exist, and that cesspools are not uncommon and of wretched construction.

"Also it is admitted that no one ever replaced the water in the street inlets (except the one at Mr. Major's corner, which he himself filled with water from time to time, having noticed that if he did not do so the smell became very bad, and penetrated into his house and shop), consequently it must follow that even if those inlets had been efficiently trapped they would become untrapped in dry weather, through evaporation of the contained water.

"Further, it is admitted that the rainfall in the spring months of this year was unusually small.

"It is a fact that after a dry time when rain came the water in the River Eau in the neighbourhood of the outfall was made of a black inky colour, owing to the rain water washing out the fermented sediment and solid matter.

"It is a fact that there is no provision for the escape of gas from the drain, and, therefore, any gas formed would find its way out at untrapped and inefficiently trapped openings, and consequently, the houses on the same side of the road as the drain would be under double fire, that is, from the street traps in the front and from the yard openings at the back, so that whether the inhabitants of these particular houses sat at their front or at their back doors, they would in either case be liable to inhale vitiated air, and to admit it into their houses ; and as a matter of fact, many people are so accustomed to unsanitary surroundings that they are quite unconscious of any ordinary bad smell, that is, they smell it with their noses, but do not take mental note of it. I have repeatedly observed this, but on close questioning can generally elicit that a smell is noticed 'against rain,' that is, the ordinary bad smell is not

observed, but when a rush of gas takes place owing to rain water driving it out they observe it because it is above the usual amount.

"2. The history of the disease itself:—

"(*a.*) The disease began suddenly early in April, attacked with special virulence old people and elderly females (that is those least active in movements and most apt to loiter about their doors and yards), it avoided children (unless the vomiting, faintness, and fever observed at this time were the manifestations of the virus in them, which I am inclined to believe). It also appeared to avoid all young adults and women in the prime of life. The majority of cases have been in the male sex.

"(*b.*) The symptoms differ from those of pneumonia as ordinarily seen in several points; thus: shock is far greater, the onset is generally marked by vomiting, often very severe, and occasionally accompanied by diarrhœa. There is sometimes much drowsiness. Headache is a marked feature, and this with the utter prostration and supine helpless condition gives the disease in its onset a strong family likeness to typhus.

"(*c.*) It is the rule to find recognisable pleurisy, which does not usually come on as a subsequent complication in the course of the disease, but announces itself with or before the rigor by pain, often excruciating and very commonly over the position of the liver.

"(*d.*) The disease appears to be infectious, yet my impression is that this infection is seldom direct; several cases have occurred which are popularly cited as instances of direct infection, the cases of Jackson, Chantry, and my father are the chief of these, but each one readily admits of another explanation, viz., that the disease was caught from the same source as that from which the sick person caught it. My personal experience of the disease is certainly against the theory that it is *highly infectious* as scarlet fever and small-pox are.

"I have attended about 22 undoubted cases of the complaint, and these patients have had between them at least 72 different nurses, yet not one of these 72 nurses contracted pleuro-pneumonia; the only possible exception that can be mentioned is the case of Jackson. Jackson's child had broncho-pneumonia, and he fell down with a disease in a week or so, but he was not actually engaged in nursing his child, indeed he did not sleep in the same room, and it is quite open to belief that he got it from the vomited matter of this or the second case in the lad of 12 who had no pneumonia.

"It must not be understood that I contend that the disease is not infectious; I simply leave the matter open, but give the negative facts of my experience, which I think go to show that the disease is not highly *directly* infectious.

"The patients, I believe, got it from one common and intensely local source, and the sequence of the cases bears this out; the cases did not crop up singly and then increase in number (always attacking those who had visited the sick person), but they came with a rush in the month of April all down the main street and on the same side as the drain, and especially where the inlets to the drain were worst in their sanitary state. Three deaths occurred in Scotter parish in January during the height of the Influenza epidemic; one in February, one in March, six in April, and six in May. I certainly think the disease can be and has been conveyed from person to person, but I have seen reason to modify my early opinion on this point, and I do not now think that this has been common in the Scotter epidemic, and where it does occur I think it is effected more as it is in typhoid, then as it is in measles.

"The enormous fatality is also a marked feature of this epidemic; the death-rate in adults in April and May being equal to 80 per cent., which is nearly four times that seen at Middlesbrough.

"3. Other arguments advanced—

"That the disease can be conveyed by sputa has been proved by my experiments with mice. In the last two Scotter cases and in the last Scotton case mice were fed on the sputa, and in each case the animals took the disease and died; in the two patients that recovered the mice showed symptoms in about 48 hours and died in about 7 days, while in the fatal case they took the disease in about 6 hours and died in 30 hours. Thus the virus is shown to lie in the sputa, and I think it will be granted that sputa would naturally be likely to find a way into the drain, seeing that the chamber utensil is the ordinary vessel in which they are received.

"It has been contended that the epidemic is entirely or almost entirely due to variation of the weather. Against this argument I must urge that Scotter is more sheltered by its situation in a valley than the 12 or 13 other villages of the sub-district, which have had but one death in an adult from pneumonia, yet any climatic variations would surely affect the surrounding places equally.

"It is also contended that as the disease has appeared in Scotton it cannot be due to any drainage defects in Scotter. Is not this like saying that typhoid fever cannot be carried from one village to another because their systems of drainage are distinct; communication between Scotter and Scotton is constant, and it appears to me that in this way the disease germ found a suitable nidus in the soil or drainage of the nearest part of Scotton, just as might occur in the case of typhoid fever."

In Scotter chiefly along the course of one particular sewer.

The distribution of the cases of "*pneumonia*" in the village of Scotter was certainly such as to suggest a local cause. The main sewer at the south end of the village drains 87 houses, of which 44 are on the east side of the main street, 26 on the west side, three in the Messingham Road, and the remaining 14 on a branch in the Gainsborough Road, several of these latter, however, being remote from any inlet. In these 87 houses there have been cases of pneumonia in 12 or 13·8 per cent.* In the 44 houses on the east side there have been cases in 10 or in 22·8 per cent.; in the 26 houses on the west side there have been cases in two or in 7·4 per cent., while in those in the Gainsborough and Messingham Roads there have been none. In the west end of the village street there are 44 inhabited houses, but of these only 17 drain into the sewers at that end of the village. Only one case of pneumonia occurred in these 44 houses (2·3 per cent.), and that in a house not drained into the sewer. In the Sands and the adjacent part of the Gainsborough Road there are 27 houses not drained into the sewer; cases of pneumonia occurred in two or 7·4 per cent., but in one of them the patient had come four days previously from the part of the village where cases were most numerous (*see* page 101), and excluding this case the proportion is 3·7 per cent. In the remainder of the parish, about 90 houses, there were five cases of pneumonia in four houses, in three the disease being believed to have been contracted in the village. There was thus a special incidence of the disease in Scotter upon the houses drained by the south sewer, which is consistent with the view that the infection was distributed by that particular sewer. There are, however, difficulties in the way of this view; thus the sewer in question has a good fall,

* To the number of cases in this part of the village should, perhaps, be added that of the man Fieldston (page 100) whose illness was probably contracted there, though it occurred elsewhere.

and at the time of my visit was clean and in good condition; probably it was in a better state than those at the other end of the village, which have less fall. (*See* appended report by the Inspector of Nuisances, Addendum D.) The south sewer receives the sewage of one w.c. while the others have none connected with them; but considering the nature of the other liquids which pass into the sewers from houses, farmyards, &c., it is not likely that the contents of the one would be on this account appreciably fouler than the others. At the time of my visit defective drain inlets were less general in the south than in the west end of the village: many of the defects in the former part having been remedied since the epidemic through the action of the Sanitary Authority, but even before this was done nuisances of this kind could hardly have been commoner at the south end than I found them at the west end. These defective drain inlets, however, are out of doors (in one case only was there one inside a workshop), and generally several yards distant from the house. I cannot therefore say that the mere abundance of drain nuisances appeared to me sufficient to account for the epidemic affecting one part of the village more than another, or affecting Scotter more than many other villages.

I do not doubt that Mr. Eminson is right in contending that the condition of the sewer was fouler at the time when the epidemic broke out than now when it has been washed out by the recent rains. A report made by Mr. Shelbourn, surveyor, of Melton Mowbray, confirms this view. The deficient flushing would, however, affect more or less the condition of all the sewers and drains in Scotter, and not only those in one particular portion of the village.

The following records of rainfall at Brigg, eight miles distant from Scotter to the N.E., are given me by Mr. Moxon:—

| Month, 1890. | Rainfall. |
|---|---|
| | Inches. |
| January - - - - | 2·15 |
| February - - - - | 0·98 |
| March - - - - - | 1·76 |
| April - - - - - | 0·46 |
| May - - - - - | 2·90 |
| June - - - - - | 2·31 |
| | 10·56 |

The average annual rainfall at Brigg is 26·74 inches.

A table of the daily rainfall in the months January to July 1890, has been given me by Dr. Harrison, Medical Officer of Health, Lincoln, 21 miles S. from Scotter. It shows the monthly amounts to correspond nearly with those at Brigg, and it may be assumed that the rainfall at Scotter during the same period was similarly deficient.

But it may be that the condition which gave rise to the epidemic was not a mere ordinary foulness, but a specifically infected state of one sewer system, the other systems never having chanced to receive the infection. This view accords better with the observed facts, but against it is the unequal incidence of the disease on the two sides of the main street, and the apparent escape of the people living in the roads leading

to Messingham and Gainsborough, though draining into the same sewer system. The main street is 30–40 feet wide, and the sewer runs near the pavement on the east side, that on which the most cases occurred, all the street gullies being on that side of the road. It would, therefore, be nearer to the houses on the side which suffered most. On reference to the map, however, it is seen that the houses in which pneumonia has occurred have not been as a rule those nearest to the street gullies.

[The cases of *sickness among children* have not been limited in the same way, but have been generally disseminated throughout the village. On the hypothesis that the vomiting, diarrhœa, &c., in children was a mild form of the same disease which in adults and old people manifested itself as a fatal pneumonia, the absence of special localisation of the children's ailment would, unless otherwise accounted for, go to discredit the influence of locality upon pneumonia. Mr. Eminson would not find much difficulty in explaining the difference if it were enough to suppose that the children contracted the disease by playing about in the street near the school around gullies communicating with the infected drain, while the older people in other parts of the village not being thus brought into contact with the infected sewer air escaped. On this hypothesis, however, the drains in other parts of the village must have been secondarily infected through the discharges of the sick children, and it is, therefore, not evident why the pneumonia of older people should not have been as generally distributed in the village as the illness of children was. The school privies are not connected with the sewer, but discharge into a cesspit, which is emptied from time to time into the vicarage garden. The boys' urinal communicates with the street drain. The master states that the illness in the spring did not, so far as he observed, affect the boys more than the girls. He also states that before June 3rd there were no children from Scotton attending the Scotter school, so that the infection can hardly have been carried to Scotton by school children. There is, however, frequent communication between the two places, on week days by people going to work, shopping, &c., and on Sundays by attendants at places of worship.]

The circumstances of the outbreaks at Scotton and Messingham do not agree with the view that the infection was distributed through the sewers. Of the three invaded houses at Scotton only one (the latest invaded) was drained into the sewer, the drains at the other two discharging into roadside ditches. At Messingham the houses invaded were in different parts of the village, and two of them were not drained into the general sewer system.

I admit that infected sewer and drain air may probably have been at Scotter one of the channels by which the contagion of the disease was conveyed (as Dr. Ballard found reason to believe that it had been at Middlesbrough), but I do not think that this view alone explains all the facts of the case, and some other agency, the nature of which is, perhaps, unsuspected, seems to be required for the propagation of the disease in outlying places. I think it likely that direct infection played a larger part than Mr. Franklin Eminson is willing to allow.* The history of the earlier cases already given seems to point to this, and although in the cases attended by Mr. F. Eminson himself the in-

* The Collective Investigation Committee of the British Medical Association give the following as their opinion (Collective Investigation Record II., p. 66): "That pneumonia is sometimes conveyed from person to person must, we think, be "admitted, notwithstanding that some of the examples quoted to that effect are "capable of other explanation. Insanitary conditions, in which ill-ventilation as "well as defective drainage ought to be included, appear to favour such conveyance, "and it would appear that the intercourse should be intimate and prolonged like "that of patient and nurse, or of bedfellows."

fectious nature of the disease was not very evident, yet these cases were mostly those which occurred later in the course of the epidemic, when a belief had arisen in its contagious nature, and more precautions were, therefore, likely to be taken against it than at first.

[The precautions directed by Mr. F. Eminson were as follows:—All sputa to be mixed with boiling water, no food from sick-room to be consumed by others than the patient, cleanliness to be observed, the hands to be carefully washed before eating, and all cups, spoons, &c., to be scalded.]

The difficulty as to the absence of multiple cases in households is lessened if we consider the milder sickness prevalent at the time to have been of the same nature, the difference in severity depending upon the age, constitution, and resisting power of the patient. There was evidence that in some cases the pneumonia attack had followed some circumstance which would weaken the power of resistance or throw strain on the lungs, such as fatigue or getting wet through.

How the infection got to Scotter in the first instance cannot be stated. As before mentioned there was a milder prevalence of pneumonia in Scotter in 1886, and it may be, therefore, that this specific infection is endemic here, starting into activity from time to time under the influence of favouring conditions. Mr. Moxon, Medical Officer of Health for the Brigg Rural District, informs me that pneumonia as a cause of death is more frequent in the iron-working villages, Frodingham, Scunthorpe, and Ashby, than in the remainder of his district, and he ascribes this to the nature of the men's work, and to the habit which they have of standing about and exposing themselves to cold when heated. Dr. Couldrey of Scunthorpe (Collective Investigation Record II., p. 6), says :—"It is the habit of pneumonia to occur in this district "in spells, with long intervals of rest when there is hardly an example "of it." Mr. Behrendt too says, (*ibidem*) "Pneumonia in my district "occurs at intervals, and then I have quite a run of cases." He also tells me that he has met with two instances in which husband and wife were taken ill of pneumonia within a few hours of each other. The community of occupation would probably lead to occasional migrations to these villages from Middlesbrough, and in this way a specific disease might be introduced from the latter place. As I have said, some of the people at Messingham work at the ironworks, and two of those who had pneumonia were employed in getting the ironstone. These cases, however, were not the earliest ones, and Messingham was not attacked until nearly two months after Scotter.

I have to thank the officers of the Gainsborough Rural Sanitary Authority, Mr. Moxon, Medical Officer of Health for the Brigg District, Mr. Behrendt of Burringham, and especially Mr. Franklin Eminson, surgeon, of Scotter, for their assistance in this inquiry. Indeed, in fairness to the last-named gentleman, I ought to say that most of the circumstances mentioned in this report had already been ascertained and put on record by him.

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Postscript, Sept. 2nd, 1890.

Since my visit to the neighbourhood, I have received information of three more cases of pneumonia. Two of the patients were of the same name and distantly related. But they did not live near each other, one living in Messingham village, and the other at a farm a mile or two distant; and they are not known to have visited each other.

1. T. W., junior, was taken ill on July 13th with a shivering fit, his illness beginning suddenly while at chapel at Messingham; when seen by Mr. Eminson first, on July 16th, his symptoms were those of an inflamed throat; and there was then no pneumonia, but pneumonia

developed two or three days later when the throat affection began to subside.

The patient was in the habit of coming into Messingham village several times a week. The sanitary condition of the premises where he lived is described as very defective, there being an ill-made drain and a foul fold yard.

2. T. W., senior, age 69, lived in the middle of Messingham, in a yard of which the sanitary condition is said to be bad, and in which cases of throat mischief had occurred early in the year. He was taken ill suddenly at 5 p.m. on July 26th with a rigor, and next day complained of sore throat, which was at first suspected to be diphtheria, but in the course of a day or two it became evident that the case was one of pneumonia On August 15th the temperature had fallen below normal, but there was still a good deal of dulness in the lower half of the right lung, and the patient was very feeble with a tendency to diarrhœa. (These particulars I learn from a letter from Mr. Behrendt to Dr. Ballard.) The patient sank and died on August 16th.

3. The last-named patient was attended during the earlier part of his illness by Mr. Wales, a medical man, aged 30, living at Burringham, a village on the Trent, seven miles from Messingham. Mr. Wales's attendance on his patient was very close, staying some time with him every day, and he had on some occasions partaken of refreshments in the house. On the evening of August 6th on reaching home he complained of feeling tired and stiff, and turned dizzy and fell. Next day Mr. Behrendt found him with a temperature of 104°, pulse 128, and respirations 52. There was dulness over the upper half of the chest on the right side, back and front, with tubular breathing and friction sound. A few days later the whole of the right lung was involved. There was vomiting one day, some diarrhœa, and slight delirium, and increasing difficulty of breathing, and he died on August 13th.*

I am informed also by Mr. Eminson that there have recently been three cases of erysipelas, two in Scotter and one in Scotton, in houses in close proximity to those in which cases of pneumonia had occurred.

* Mice fed with the sputa of this case remained well throughout, unless a degree of sluggishness on the part of one of them, which lasted only for a day, were a sign of illness.

## ADDENDUM A.

The following are the deaths ascribed to pneumonia which have occurred in the Gainsborough Rural Sanitary District (elsewhere than at Scotter and Scotton) in the first six months of 1890:—

| Date. | Place. | Sex. | Age. | Certified cause. |
|---|---|---|---|---|
| January 12 | Blyton | F. | 11 months | Broncho-pneumonia.* |
| January 17 | Willingham† | F. | 17 years | Pneumonia, meningitis (tubercular). |
| January 15 | Kexby | M. | 5 months | Pleuro-pneumonia. |
| January 19 | Willingham | M. | 40 years | Pleuro-pneumonia. |
| February 6 | West Ferry | M. | 15 months | Pertussis, broncho-pneumonia, convulsions. |
| February 25 | West Ferry | M. | 2 years | Broncho-pneumonia. |
| March 12 | Morton | M. | 32 years | Phthisis, pneumonia, exhaustion. |
| March 18 | Hemswell | F. | 38 years | Pneumonia (childbirth), exhaustion. |
| April 30 | Misterton | M. | 59 years | Acute pneumonia. |
| May 1 | Glentworth | M. | 39 years | Pneumonia (double), 7 days. |
| June 6 | Glentworth | M. | 67 years | Cardiac disease, 1 year; pneumonia, 4 days. |
| June 6 | Misterton | M. | 10 months | Pneumonia. |
| June 16 | Morton | M. | 56 years | Pneumonia, 14 days. |

* Mr. Eminson states that this affection was secondary to influenza.
† In a cottage hospital, patient having been brought from Torksey.

## ADDENDUM B.

DEATHS FROM ALL CAUSES IN SCOTTER PARISH TO JUNE 30TH, 1890.

| Date. | Initials. | Sex. | Age. | Certified cause. |
|---|---|---|---|---|
| January 11 - | W. M. - - | M. | 45 | Chronic bronchitis, influenza, capillary bronchitis, 4 hours. |
| January 27 - | T. B. - - | M. | 80 | ? Old age. |
| January 24 - | S. S. - - | F. | 63 | Acute bronchitis. |
| February 7 - | G. K. - - | M. | 19 | *Enteric fever. |
| March 11 - | R. B. - - | M. | 80 | Old age. |
| April 10 - | J. B. - - | M. | 82 | †Old age. |
| April 13 - | M. H. - - | F. | 84 | †Old age, diarrhœa. |
| April 23 - | E. H. - - | F. | 31 | †Influenza, 2 months: pneumonia, 2½ days; childbirth, 36 hours. |
| April 26 - | J. A. F. - - | F. | 61 | †Acute broncho-pneumonia. |
| April 29 - | E. C. - - | M. | 59 | †Acute pneumonia. |
| April 30 - | H. C. - - | F. | 63 | †Cerebral congestion. |
| May 1 - - | G. H. J. - - | M. | 37 | †Influenza; pleuro-pneumonia, 6 days. |
| May 2 - - | H. S. - - | F. | 80 | †Influenza, bronchitis. |
| May 5 - - | H. C. - - | M. | 33 | †Epidemic pneumonia, 4 days; bronchitis. |
| May 4 - - | H. T. - - | F. | 71 | Paralysis, exhaustion. |
| May 17 - - | F. H. - - | F. | 82 | †Pleuro-pneumonic fever, 5 days. |
| May 25 - - | W. B. - - | M. | 50 | Apoplexy, 48 hours. |
| May 25 - - | R. A. C. E. - | M. | 41 | †Pleuro-pneumonic fever, 9 days. |
| June 8 - - | R. E. - - | M. | 80 | †Pleuro-pneumonic fever, 1 month. |
| | DEATHS IN SCOTTON. | | | |
| May 9 - - | T. C. - - | M. | 57 | †Epidemic pleuro-pneumonia, bronchitis. |
| July 1 - - | J. C. - - | M. | 69 | †Pleuro-pneumonic fever; bronchitis, 12 days. |

* In an outlying part of the parish. Came ill from Gainsborough.
† The deaths marked thus are believed to have been from the disease under investigation.

## ADDENDUM C.

The following clinical histories are furnished me by Mr. Franklin Eminson, and are in his words.

CASE 1.—G. H. J., aged 37, farm labourer, Scotter.

*Previous history.*—Always enjoyed good health, possessed great physical strength, his master considered him one of the strongest men in the parish. His mother died of chronic phthisis after her second marriage. About two months before the present illness he had influenza, as well as his wife and children. He consulted me for a dental neuralgia of moderate severity which followed it; it was not of the violent, maddening kind that is occasionally seen as a sequel to influenza. He was a most temperate man.

*Present illness.*—He began to be ailing about April 24th, but did not lay by entirely, and on the Saturday, April 26th, he came down to Scotter, a distance of a mile or more, but felt done up on his return, and wrote a letter to me to ask for a little medicine, as he was "sick and bilious" and had a "bad cough." The following day, April 27th, I was sent for, and found him in bed with a temperature of 104·2, face flushed, but

breathing not notably accelerated. There was pneumonia of small patch of lung in left lower lobe. Next day I prescribed Dover's powder for pain of pleurisy, which was now detected. Temperature 101. On the following day, April 29th, an alarming change had occurred in the condition of the pulse, which appeared to be rapidly giving way. The temperature was 101. Delirium now came on, and I sat up with him all night to try to subdue this untoward symptom, but failed to control it, and he shouted, sang, prayed, and exhorted in turn all through the night, and, to a less extent, the following day and night, till his death on May 1st. He died while I sat by his side talking and attempting to get out of bed up to the last. Loud tubular breathing was heard along nearly the whole extent of lung in back on the last day or two.

*Omitted from above account.*—On April 16th I was called to little girl, daughter of above, and found broncho-pneumonia, with temperature 102. The child had been at school at Scotter, close to the most insanitary part of the village. She recovered gradually, but in about a month had a large abscess outside the elbow. On April 20th, on my visit to the girl, I found boy aged 12 in bed, with temperature 101, foul tongue, vomiting, severe pain in head, and *great prostration*. He recovered in a few days, but was very weak. I may say that the symptoms shown by this lad were exceedingly common at this time amongst the school children. I saw possibly a dozen such, but many more never came under my notice. They were taken suddenly with vomiting, pallor, prostration, and then fever, this passing off in from a few hours to a few days.

Case 2.—H. C., 33, farm labourer, Susworth (three miles from Scotter).

*Previous history.*—Was very delicate as a child, and his parents never expected him to grow up to manhood. Had bronchitis frequently till he reached adult age. Some months ago he and his children had diphtheria, owing to bad sanitary arrangements about his house, but he recovered perfectly.

*Present illness.*—His mother, aged 63, died of pneumonia on April 30th. She was exceedingly delirious, hardly being conscious throughout the entire illness, and H. C. sat up with her for three consecutive nights till she died, walking to Scotter in the evening and back to Susworth to his work in the morning.

The day after his mother's death (May 1st) he was taken while at work in the fields with a rigor and, I think, with vomiting. I saw him on the morning of May 2nd, his condition and appearance were striking—the face, neck, and ears were flushed and livid, the ears being purple at the tips, his chest was heaving, dyspnœa being marked from the first, his pulse was rapid and small, temperature 102. There was great pain over the liver region, and evidence of pleurisy was found there, as well as bronchitis in both lungs. Pneumonia rapidly declarged itself in the right middle lobe, and he sank in four days from the beginning of the attack. The highest temperature observed was 103. Expectoration was very copious, frothy and rusty, and latterly bright red.

Case 3.—J. N., aged 65, horsebreaker, Scotter.

*Previous history.*—On July 31st, 1889, I was called to him late in the evening, and found him in a condition of high fever, temperature 104·2, bounding pulse, flushed face, and rather inclined to wander in mind. I could find no cause for the fever, but considered his condition grave, but next morning was astonished to find him almost quite well, temperature being 99·4, and all signs of acute illness gone. On that date (August 1st) I took the following notes: "Has a very extraordinary condition of right "thigh and leg, there being several round punched-out ulcers, with "breaking down, pus lined bottom, and many scars of old healed ulcers "about and above the knee. The leg is immensely swollen and skin "thickened, and there is one recent ulcer on inner side of calf. The "cause is believed to be connected with his calling, having had ulcers "30 years, and having spent most of his working time in the saddle."

*Present illness.*—On June 7th and 8th he felt poorly, and had a sore throat, but continued about his work, driving on the 8th to see a sick horse. Besides sore throat he had slight pain across chest. I was called to him on June 11th, and found him in a condition closely resembling that

observed a year before, temperature 104·5, flushed face, anxiety, and tendency to wander; he was not sick; the breathing was not accelerated, and nothing could be detected amiss in the lungs, but the sputa was tinged of a brown-red colonr, and there was a little cough. Next morning, the temperature was 100 and breathing 30, and I hoped the attack might abate, but at night the temperature was 104·2, respiration 44, and pulse over 100. At 8 a.m., June 13th, temperature was 100, respiration 36, and pulse 100. Sputa viscid and rusty. I now found breathing deficient in left base, but throughout the case very little sign of pneumonic mischief could be found, yet three mice which were fed on the sputa died in the course of a few days. In the evening the temperature was 102·4, respiration 50, and pulse more rapid. Next morning, June 14th, the temperature was normal, respiration 36, and he seemed much better; in the evening temperature was normal, respiration 24, and pulse 84. From this time he mended continuously, and was downstairs on the 20th. He never had much pain, and the case, though smart, was one of the mildest I have seen.

Case 4.—J. C., aged 70 (a few days short), farmer, Scotton.

*Previous history.*—Was a powerful, ruddy, and thickset man, apparently very robust, but he had had several attacks of bronchitis, one some years back being severe. About three years or more ago, he and his family had a very extraordinary attack of rheumatic fever. I did not attend them, but my father who did, described the cases to me. The members of the family began one after another to be ill, with what my father believed to be rheumatic fever, until every member of the family, except, I think, the mother, was ill or recovering from it. (I may mention that acute rheumatism was epidemic in the neighbourhood about that time; I had two first attacks in old people, one being over 70.) The signs and symptoms were those of an ordinary case with the addition in each case of an extensive purpuric rash, and I thing there were swellings on the limbs, such as one sees in erythema nodosum. The cases were very obstinate, some being several months before perfect recovery was established. Ultimately all recovered.

*Present illness.*—On the evening of June 17th he had been to Scotter close to where many cases of pneumonia have occurred; he was quite well next morning, and went to work in the fields; rain fell, and he got wet about the legs, and did not change his clothes (nothing unusual with farmers), but came home and worked in his garden till late in the evening, when he came in-doors and went to bed, not feeling quite well. He passed a restless night, and at 2.30 a.m., June 19th, a rigor came on, and I saw him at 5.30. He was flushed, complained of headache, and of a sharp pain over liver region; temperature 102, pulse 96, respiration 32. Nothing definite was found in the lungs, breath sounds seemed normal, though harsh. In evening the temperature was 100, respiration 28, and pulse 84. June 20th, he was same, only some bronchitic sounds were heard in lungs and distant abnormal breath sounds were heard in right back. On 21st temperature was 105, respiration 36, pulse 108; pain had returned in right side, and coarse moist sounds were now heard over seat of pain, also tubular breathing in right middle back. On 22nd pain had gone, but besides signs of pneumonia there was considerable bronchitis all over both lungs, but worst in the right. No wandering. He continued in this way, pulse getting quicker, till June 26th, when pulse was 112 and temperature 100, and now a quiet, cheerful kind of wandering came on. On 27th temperature was 99, and continued about same, so that I had hopes of recovery, but expectoration became loss, while pulse and respiration remained quick, and he died early on the morning of July 1st, having sat up in bed to sing a hymn with his children shortly before.

Case 5.—G. V., aged 50, farm labourer, Scotter.

*Previous history.*—No illness ascertained; has been intemperate; formerly in militia.

*Present illness.*—Began suddenly on his return from work at Scotton on evening of June 21st, with rigor and nausea, but no vomiting; could not undress himself, but his wife had to put him to bed. I saw him 24 hours after (June 22nd), and found him with flushed face and considerable

prostration; his temperature was 102·5, pulse 100, and respirations 35. There was right pneumonia, tubular breathing being heard below spine of scapula. Some bronchitic sounds were also heard on same side, though not extensively. On 23rd, temperature was 102 in morning, 101 evening, respirations 32, and pulse 100 and 92. On 24th, at noon, temperature was 104·1, and pulse appeared to be failing in force. 25th, temperature 102, pulse 100. 26th, temperature 102·6, respiration 44. Expectoration considerable, rusty and tenacious from beginning. No vomiting, and took food well throughout entire course of disease. Wandering came on June 27th, but there was no violence; he tried now and again to get up and go about his work, but his wife could easily control him, and he was not noisy. On evening of 27th the temperature was 102, respiration 50, pulse 112; but next morning temperature was normal, respiration 42, but pulse 120. After June 28th, the temperature continued normal or nearly so, but the pulse gave cause for anxiety, being hesitating, irregular, and rapid. On June 30th, temperature was normal, respiration 36, and pulse 100, halting; but by July 2nd the pulse had come down to 84; breathing was now good, except at site of pneumonia, where medium moist sounds were heard. Expectoration had now become frothy and white.

On July 5th he was progressing towards convalescence, but calf of right leg was very painful, owing to inflamed state of superficial veins.

Case 6.—The following is a chart of the temperature, &c., in the case of R. A. C. E., aged 41, who was taken ill at 5 a.m. on May 19th:—

| Day. | Hour. | Temperature. | Pulse. | Respirations. |
|---|---|---|---|---|
| | | F. | | |
| May 19 | 11. 0 a.m. | 104·6 | 84 | 24 |
| | afternoon | 101· | 96 | 24 |
| | 10.30 p.m. | 98·4 | 84 | 20 |
| May 20 | 10.15 a.m. | 100·4 | — | — |
| | 4.30 p.m. | 99·6 | — | — |
| | 8.30 p.m. | 100·6 | — | — |
| May 21 | 7. 0 a.m. | 102·5 | — | — |
| | 11. 0 a.m. | 102· | — | — |
| | afternoon | 102· | 92 | 24 |
| | 9. 0 p.m. | 99·4 | — | — |
| May 22 | morning | 102· | 92 | — |
| | afternoon | 102·8 | 84 to 92 | 26 |
| | 8.30 p.m. | 100·6 | — | — |
| | 10.45 p.m. | 99·2 | — | — |
| May 23 | 6. 0 a.m. | 100·4 | — | 20 |
| | noon | 102· | — | — |
| | 9. 0 p.m. | 100·4 | — | — |
| May 24 | 4. 0 a.m. | 100·4 | 90 | — |
| | 8. 0 a.m. | 100·6 | — | — |
| | afternoon | 102·2 | 96 | 20 |
| | 11. 0 p.m. | 101· | 96 | 20 |
| May 25 | 5. 0 a.m. | 101·4 | — | — |
| | 8. 0 a.m. | 102·2 | 96 | 24 |
| | 2.30 p.m. | 104· | 104 | — |
| | 9. 0 p.m. | 102· | — | — |
| May 26 | 4.15 a.m. | 100·6 | — | — |
| | 8. 0 a.m. | 101·4 | — | — |
| | 11. 0 p.m. | 102· | — | — |
| May 27 | 3.30 a.m. | 101·6 | 120 | — |
| | 9.15 a.m. | 102·4 | — | — |
| | 1.30 p.m. | 103·8 | — | — |
| | 3.30 p.m. | 100·4 | — | — |
| | 8.30 p.m. | 102·6 | — | — |
| May 28 | 1. 0 a.m. | 101·6 | — | — |
| | 4.30 a.m. | 103· | — | — |
| | 6.30 a.m. | 103· | — | — |
| | Death. | | | |

Case 7.—The following is a table of the temperature, &c., in the case of W. M., aged 56, who was taken ill at 9 a.m. on May 31st:—

| Day. | Hour. | Temperature. Fahrenheit. | Pulse. | Respirations. |
|---|---|---|---|---|
| June 1 - - - | noon | 102·8 | — | — |
| | eve | 100·8 | — | — |
| June 2 - - - | noon | 100·8 | — | — |
| | eve | 102·8 | — | — |
| June 3 - - - | noon | 103· | 104 | 30 |
| | eve | 102·2 | — | — |
| June 4 - - - | — | 102· | — | — |
| June 5 - - - | noon | 103· | — | — |
| | eve | 104· | 112 | 30 |
| June 6 - - - | noon | 103·2 | 120 | 48 |
| | eve | 103·5 | — | — |
| June 7 - - - | Died | | | |

## ADDENDUM D.

To the Chairman and Members of the Rural Sanitary Authority. Scotter Parish.

Gentlemen, 30th June 1890.

I beg to report that the brick cesspools in the streets have been taken up and earthenware street gullies fixed in their places. The principal sewer at the points where the gullies were connected was found perfectly clean. I also had the pipes opened where the drain from the rectory is connected, and at this point both the sewer and the drain were perfect.

The sewer throughout is laid very near the surface, but the joints of the pipes were found to be secure, at least there were no signs of leakage; this, I think, proves that there can have been no smell arise from the course of the sewer. The fall is good, but I should imagine the pipes seldom run half full, and the velocity decreases with the diminution of the depth of water flowing; the liquid is the carrier of the solid portions, which have a constant tendency to settle to the bottom of the pipes, and if the liquid be insufficient in quantity to cause the necessary velocity the solid part of the sewage necessarily settles, and gradually chokes up the drain.

If it is found that in dry weather there is insufficient water running in the sewer to carry the solids then some arrangement must be made for flushing.

A few manholes would give ready means of access for inspection and flushing if necessary, and the cost would not be great.

Ventilating shafts would greatly relieve the pressure on the traps in the streets and yards.

A short sewer at the Susworth end of the village was found to have about three inches of water standing in it; this was caused by the outfall not being clear. I gave notice to the occupier of the field adjoining the outfall to clean out the dyke, and he promised to do so.

I am, gentlemen,
Your obedient servant,
William Eyre,
Sanitary Inspector.

## No. 13.

### On some Localised Occurrences of Cerebro-spinal Meningitis in certain Parishes of the Eastern Counties; by Dr. R. Bruce Low.

In August 1890 the Board received information of the occurrence, at more places than one in the east of England, of a malady presenting many of the features of cerebro-spinal meningitis; and I was instructed to make inquiry into the facts.

Statements about such disease had come from certain parishes on the boundary of Suffolk and Norfolk, and from a single parish (Great Horkesley) in Essex. Later, in the course of the inquiry, I got information of similar occurrences in a different quarter of Essex and in two districts in Lincolnshire.

The facts about the several localities affected I shall deal with in the above order, prefacing my remarks by a short statement of the topography of the area of Suffolk and Norfolk wherein the chief group of cases was found.

#### Suffolk and Norfolk (Oakley and Neighbourhood).

*Oakley*, in the Hartismere Rural Sanitary District, is in a thinly populated parish situated on the Suffolk side of the river Waveney. The present population is estimated at rather less than 300, spread over an area of 1,289 acres. There is a small aggregation of population at one point, which may be regarded as the village, but the houses are mostly scattered over the parish singly or in small groups. Locally the parish is divided into a Lower and an Upper part, the former being nearest the river. The village of Oakley lies equidistant between the towns of Eye in Suffolk and Diss in Norfolk, two and a half miles from either place. The people are employed in agriculture. The subsoil is gravel and clay.

*Brome*, also in the Hartismere Rural Sanitary District, is a parish immediately adjoining Oakley on the south. It has a population of about 250 persons, and an area of 892 acres. The people here live under conditions almost identical with those existing at Oakley. The same church and school serve both parishes.

*Scole*, in the Depwade Rural Sanitary District, is situated immediately north of Oakley, on the Norfolk side of the river Waveney. A bridge connects the two parishes. Scole village lies about a quarter of a mile from the river. The population of the parish is estimated at rather less than 600; the area is 821 acres. The houses in some parts of the village are crowded somewhat closely together; in some cases cottages

are built behind the houses forming the main street. From Scole post office the letters are distributed to Oakley and Brome. Some Oakley people do their shopping at Scole, and some men and boys from the latter place find employment daily at one or another of the farms situated in Oakley parish.

*Bressingham*, also in the Depwade Rural Sanitary District, is a parish five miles north-west of Oakley, on the Norfolk side of the Waveney. Its area is 3,354 acres and its population about 500.

*Kenton*, in the Plomesgate Rural Sanitary District (Suffolk), is a small parish about eight miles, as the crow flies, south-east from Oakley. It has a population of about 300, and an area of 1,208 acres.

### *Oakley Cases.*

*In Oakley* I heard of a dozen attacks during the month of July, all of them presenting very similar symptoms, and of a sort leading the several medical men in attendance on the cases to the conclusion that they had to deal with a malady new to their experience.

The symptoms in question, and they were much the same in all the localities referred to, were in the main these :—The patient was taken ill suddenly with vomiting, vertigo, headache, and great prostration. Next day, or even later, there was pain and stiffness in the neck and back, passing sooner or later into complete retraction of the head, in some cases amounting to opisthotonos. Early in the illnesses there was great drowsiness; in young children fits of screaming occurred when they were awakened. There was rise in temperature, which ranged from 100° to 103°. Delirium followed in most cases. Some had conjunctivitis, others herpes of the mouth. There was usually great sensitiveness of the skin. All, or nearly all, had more or less loss of power in the lower limbs. Emaciation was rapid and convalescence was slow. The pulse was sometimes noticed to be dichrotic, and the respiration was hurried or interrupted. Some cases had neurotic sequelæ. A rash was seen in only three cases. One case proved fatal at Oakley. The duration of the disease varied from three or four days illness in mild cases, to three or four weeks in more severe attacks.

The 12 Oakley cases were distributed among six families, and occurred in the following order :—

*Oakley, 1st family invaded, 1 case.*

*On July 10th* H. S.,* aged 10, the son of a farm labourer, residing in Lower Oakley, was suddenly seized in Oakley cum Brome school with headache, vomiting, and vertigo. Next day his neck was stiff and his head became retracted. He was feverish and drowsy, and later on delirious. He lost the use of his legs. There was great constipation (no motion for eight days). His mother states he passed no water for four days. His skin was very tender to the touch. He sweated profusely at times. His life was in danger for two weeks. When I saw him on September 10th he was pale and emaciated, and had paralysis of the flexors of his right arm. No other cases followed in this family.

*Oakley 2nd family invaded, 3 cases.*

*On July 15th* K. B.,† aged 8, the daughter of a farm labourer, residing at Upper Oakley, half a mile from the previous case, was similarly seized, and like H. S. in the same school. Her case resembled his in most particulars, but she had conjunctivitis, and a rash, her

* For some medical particulars of this case I am indebted to Mr. Wright, of Eye.

† For much valuable information regarding this and the rest of the Oakley cases I have to thank Dr. E. G. Barnes, of Eye, and his assistant, Dr. R. C. Lewis.

mother says, "like chicken-pox." Her head was retracted. She made a good recovery. Later on two more cases followed in the same family, viz., A. B., aged 18 months, attacked "about" July 22nd, and J. B., aged 3, attacked "about" July 29th. Both had spots "like chicken-pox," and conjunctivitis, with retraction of the head. One had extensive herpes labialis. Both recovered, but the boy, aged 3, suffered for some weeks from apathy, bordering upon imbecility, after the subsidence of the acute symptoms.

*Oakley, 3rd family invaded, 2 cases.*

*On July 24th* two children (C. F., aged 4, and G. F., aged 2), the son and daughter of a farm labourer, residing about 400 yards from the last-described cases in Upper Oakley, were taken ill simultaneously, so far at least as can be learned, with symptoms as in the previous cases. The elder child fell ill while at school; his illness soon passed off, lasting only four or five days. The younger one had a bad attack. The mother says she had no rest for three weeks. Both cases had retraction of the head. The youngest child had still in September complete paraplegia.

*Oakley, 4th family invaded, 3 cases.*

*On July 25th* E. B., aged 2½, the son of a gardner, residing at Upper Oakley about 200 yards from the last cases, was taken ill just like the others. He had a stiff neck and retraction of the head. He lost the use of his legs for a fortnight. He had conjunctivitis. He recovered with a squint and some deafness, but this is now (September) passing away. Two more cases followed in the family, viz., D. B., aged 7, who came home ill from school on July 27th, and W. B., aged 7 months, taken ill on July 29th. The elder, a girl, had a severe attack, complicated with alarming hematemesis on the seventh day. But she recovered. Both children had conjunctivitis and retraction of the head. The children in this family were cousins of the children in the second family invaded.

*Oakley, 5th family invaded, 2 cases.*

*On July 25th* another family was invaded in the person of A. C., aged 10, the son of a labourer residing in Lower Oakley near the river, about half a mile from Scole and rather more than that distance from the previous cases in Oakley. This boy fell ill in school, and was accordingly sent home; but he occupied two hours in covering a distance of less than a mile. He had to lie down on the roadside many times by the way. He had nausea, headache, vertigo, prostration, and pain in the neck. His head, next day, was retracted. He became drowsy, and died comatose on July 27th, about 48 hours after his seizure. Medical advice had not been sought till a short time previous to his death. He died before a doctor reached the house. An inquest was held, and after hearing the evidence of Dr. R. C. Lewis, who had made a post-mortem examination, the jury returned a verdict of death from cerebro-spinal meningitis.

The following notes of the post-mortem examination were furnished to me by Dr. Lewis:—

"Body well developed and well nourished; no rash—a few purpuric spots on inside of the thigh and back of arms. Marked hypostatic staining of skin on posterior aspect of body. *Brain.*—Great congestion of whole membranes, and venous system generally gorged with blood. Along upper surface shows evidence of lymph having been thrown out; also on basis. Serum was found in ventricles in great quantity; substance soft. *Spinal cord* itself healthy, but membranes very congested (upper dorsal region). *Lungs, heart,* and *pericardium*

normal. *Stomach* greatly distended with gas; anterior and upper surfaces normal. Posterior surface, where in relation to spleen, dark and soft, but mucous membrane shiny and not ulcerated. Small spots resembling minute extravasations in submucous coat. Contents fluid, peasoup in character, 2 to 4 ounces in quantity. *Liver*, *intestines*, and *peritoneum* healthy. *Spleen* slightly engorged. *Kidneys* healthy. *Blood* fluid, venous in character."

*On July 27th*, the day of A. C.'s death, his brother, G. C., aged 8, was suddenly taken ill with headache, vertigo, vomiting, stiffness and pain in neck and back, fever and drowsiness. He had herpes of the mouth. He lost the use of his legs; his head became retracted. He recovered after four weeks' illness. When I saw him on September 10th, he was still weak, pale, and emaciated. He dragged one of his legs in walking.

These five families, comprising 11 cases, are those personally visited by me; but since I left Oakley I have been informed of another case which began on July 25th.

*Oakley, 6th family invaded, 1 case.*

C. C., aged 11, the son of a widow living in Lower Oakley, was taken ill in school *on July 25th*. He had headache and sickness and the other symptoms, but all in a mild form. He recovered, I am told, after only a few days' illness.

### *Brome Cases.*

*In Brome*, at the time of my visit in September, I did not hear of any cases, nor were any then known to the Medical Officer of Health, Dr. Barnes. But recently I have received from a local correspondent information of two cases, whose illness appears to have been identical with that which occurred at Oakley. Both children attended the Brome and Oakley school.

*Brome, 1st family invaded, 1 case.*

E. C., aged 6, is stated to have been taken ill *on July 23rd*. After some weeks of illness she was removed to the county hospital at Norwich. From the Resident Medical Officer, Mr. Vance, I hear that this girl is under treatment for "myelitis." I regret I cannot give the medical details of the early part of the girl's illness, for the medical man who attended her has not replied to either of two letters of inquiry which I have addressed to him.

*Brome, 2nd family invaded, 1 case.*

The second case was J. W., aged 10. His symptoms are said to have been mild, and he was not medically attended. He began to be ill about *August 7th*, and made a speedy recovery.

### *Scole Cases.*

*At Scole* four cases* were recognised. They were confined to two families. The first cases in each family were youths, aged respectively 13 and 14, companions, whose habit was to spend their evenings together. They worked on different farms, one in Oakley parish, the other in Scole. Both lads began to be ill on the same day. A second case followed in each family later on.

*Scole, 1st family invaded, 2 cases.*

H. T., aged 14, became suddenly ill *on July 30th*, while driving sheep on the high road some miles from home. He had to lie down

* For details of the Scole cases I am indebted to the medical attendants, Messrs. Amyot and Hubbard, of Diss.

many times on the wayside before he could reach his father's house in Scole. His case was at first thought to be one of sunstroke; but the day was dull, and as afterwards there was well-marked retraction of the head, as well as other symptoms, and as also a second case followed in the family, the illness came to be regarded as the same as that which had just been occurring before this at Oakley. During this lad's convalescence he had painful swellings in some of the larger joints. About a month later, *i.e.*, about September 1st, his brother, F. T., aged 17, was seized much in the same way, with headache, vomiting, and intense vertigo. Retraction of the head was not noticed in this case. He recovered in about a week. These two brothers worked on the same farm in Oakley parish, at which the father of A. C. (the fatal case already recorded) also worked.

*Scole, 2nd family invaded, 2 cases.*

J. L., aged 13, was suddenly taken ill in the hayfield on *July 30th*. He suffered from nausea, vertigo, and headache. He was taken home by his comrades, and was supposed then to be suffering from sunstroke. He developed delirium; his head became retracted. He had a severe attack, and was off work for four weeks. His sister, F. L., aged 7, became ill, in Scole school, on August 7th. Her symptoms were almost precisely the same as her brother's, including delirium and retraction of the head. Her illness lasted only two weeks and she made a good recovery.

### *Kenton Case.*

*At Kenton* only one case was reported, and regarding it there was some difference of opinion.

*Kenton, 1 case.*

F. L., aged 26, a farmer, was taken ill on *August 26th* with violent headache, vomiting, and vertigo. Dr. Hannigan, of Debenham (to whom I am indebted for the medical facts of the case), saw him the same night. There was well-marked spasm of the muscles of the neck, back, and abdomen. The head became retracted. Mottling of the skin over the abdomen and back was noticed. The patient complained of severe abdominal pain. He gradually became pulseless and died in less than 48 hours from the onset of the acute symptoms. He was conscious to the last. It was said he had sunstroke some two years ago, and that he had lately been addicted to alcohol. For a month before his death he had complained to his friends of vague symptoms, *e.g.*, a feeling of unusual drowsiness and of weakness. Dr. Barnes, of Eye, who had had the advantage of seeing most of the Oakley cases, saw the case in consultation, but he could not satisfy himself that the man was suffering from cerebro-spinal meningitis. The patient was moribund at the time.

### *Bressingham Case.*

*At Bressingham* one case occurred.

*Bressingham, 1 case.*

A child, aged 5, was attacked on *September 7th*, with the usual train of symptoms already mentioned, including retraction of the head and hyperæsthesia of the skin. She recovered, and no further cases have been heard of there since. The particulars of this case were sent to me by Mr. Hubbard, of Diss, after I had left Oakley.

The above 20 cases comprise all known to have occurred in Oakley and the surrounding parishes during July, August, and September.

While making inquiry in these different places as regards the occurrence of marked cases of cerebro-spinal meningitis, an endeavour was also made to ascertain the prevalence, if any, of minor malady, which might possibly have been due to milder manifestations of the same disease. For this purpose I communicated personally or by letter with nine or more medical men practising in one or other of the localities already named inquiring for attacks of minor illness characterised by symptoms as follows, or some of them:—Persistent headache, nausea, vertigo, muscular malaise, pains in head, neck, or limbs, and attacks of chilliness ending in profuse sweating. But from none of these gentlemen, except Mr. Wright, of Eye, could I hear of any such cases. Mr. Wright mentioned to me a female, aged 50, who had been suddenly taken ill, about August 26th, with vomiting, pains in the joints, back, and neck. The acute symptoms lasted five days, and were much relieved by a blister over the nape of the neck. There was prostration for a time after.

[On looking over the mortality returns for the current year for the Hartismere Rural Sanitary District, in which Oakley is situated, with a view to fatal cases which might have been of the nature of cerebro-spinal meningitis, I failed to find any evidence of such, except that a young woman, aged 24, a servant, died of meningitis just outside of the town of Eye on July 17th (1890); but Dr. Barnes, who attended the case, assures me the case was in no way, in his opinion, allied to the epidemic disease which he witnessed at Oakley. Two deaths of adults, aged 18 and 32 respectively, were certified from epilepsy, one in January at Palgrave, 3 miles from Oakley, the other on July 25th at Eye, 2½ miles from Oakley. A death from tetanus after injury took place in March (1890) at Yaxley, 3½ miles from Oakley.]

The outbreak under consideration followed in a great measure the course of similar outbreaks related by writers elsewhere. There was a definite group of cases with associated scattered cases in the neighbourhood, but with no apparent connexion between them.

The people at Oakley are all engaged in agriculture. The families attacked there were all of the labouring class. The cottages, though mostly not of recent construction, are, as a rule, free from damp; the floors are bricked and the roofs are of thatch or of tile. The ceilings are somewhat low. Most houses have three bedrooms. In none of the cottages that I visited did I find a dirty interior, nor did I perceive any foulness or closeness of the air in the living or sleeping apartments. On the whole the condition of the cottages in Oakley, as regards cleanliness, cubic space, ventilation, and absence of dampness, compared favourably with houses of the same class in other localities known to me. There is no proper sewerage in Oakley. The excrement disposal is by means of pit-privies, emptied on the land once or at most twice a year. House refuse is utilised in gardens and allotments. The water-supply is got from pump-wells or from open pits. The water in the latter case is said to be boiled before use.

There appeared to be nothing to distinguish the sanitary surroundings of persons attacked from those of persons who escaped. The general conditions under which the invaded families lived were in no way different, so far as could be seen, from those of the rest of the population. They were neither worse fed, clothed, or housed than the others. The wages of the agricultural labourer in Suffolk are low, but during the inquiry no noticeable indications of poverty or privation were met

with. In none of the Oakley cases was there any evidence of insufficiency of food or of clothing, or any facts pointing to the condition known as "general misery," to which some writers attribute the disease.*

Some inquiries were made regarding the nature and source of the food supplies, with a view to determine if mouldy flour or grain had been used; or if the flesh of diseased animals had been eaten. But these yielded negative results. Importation of the disease was also considered, but no evidence was forthcoming to throw light upon the origin of the outbreak from this direction. It is true there had been arrivals of foreigners in the parish in the early part of the year; but no visitor from abroad had been known to have been near the parish since April, three months or more before the outbreak. The question of tramp routes was also inquired into. Travellers to Diss from the south may come through Lower Oakley. There is a public-house not far from the cottage first invaded, but no connexion between the occurrence of the disease and tramps or strangers visiting at the public-house could be traced.

In general it may be stated that no satisfactory decision has been come to as yet regarding the origin of this outbreak; nor has it been found possible to account for the extension (if it occurred) of the disease from the first case to the others by one or other of the usual conditions known to us under which diseases ordinarily spread. Details of the negative evidence collected during the inquiry have been preserved, and are available for future use, should other similar outbreaks come under notice.

## Essex (*Great Horkesley*).

*Great Horkesley*, in the Rural Sanitary District of Lexden and Winstree, lies 30 miles due south of Oakley. It is situated near the river Stour, the boundary between Suffolk and Essex, and is 4 miles north of Colchester. The population is about 700, and the area is 3,048 acres.

*Great Horkesley, 1 case.*

G. S.,† aged 20, an agricultural labourer, was taken ill while loading grains at a brewery 3 miles from home, on the forenoon of *August 9th*. He says he suddenly felt faint, vomited, had dizziness and headache. He was found by his fellows lying down in a collapsed condition. He was taken home in his cart. It was supposed that he had had a sunstroke. Twenty-four hours later there was a strong contraction of the muscles of the back and neck; his head became retracted at right angles to the body. He had great sensitiveness of the skin. His eyes were red and

* In this connexion it may be mentioned that in only one family out of the total visited during the inquiry did I find any indications of neglect and improvidence. This exception was at one of the two houses invaded at Scole. The father, an idle drunkard, spent most of his days in bed, and most of his evenings in the beerhouse. The mother maintained the family by charing. In her absence the house and children were neglected. Of the five children, the eldest boy worked on a farm, another child went to school; the younger ones left at home all day were often fed by the compassionate neighbours. The boy and the four other children slept together in one bed. The house was almost destitute of furniture. The children were poorly clothed and not clean. The two cases in this home were the boy of 13 and a girl aged 7, who attended Scole school.

† For the medical facts of this case I am indebted to Messrs. H. D. Palmer and F. W. Day, of Nayland, the medical men who attended him.

injected; he had constipation. He became drowsy and stupid; delirium developed. There was some fever. His life was despaired of for some time. He lost the use of his legs, and was unable to stand for three weeks. He was still confined to bed when seen by me on September 12th; he was then pale, weak, and thin. Inquiries made at Great Horkesley and Nayland failed to discover any trace of other similar cases.

*Maldon Rural Sanitary District.*

During the autumn months of 1890 a number of cases of "typhoid" were notified to the Medical Officer of Health, Dr. J. C. Thresh. Upon investigation by this gentleman these so-called typhoid cases were found to be exceedingly obscure in their origin; the symptoms, too, were anomalous; some proving fatal in a few days from the first onset of the illness. At my request Dr. Thresh was kind enough to make special inquiry into these doubtful cases. Owing to difficulties in obtaining information Dr. Thresh, after taking much pains, and spending much time in the effort, was only able to give me details of the following:—

F. A., aged 23, a labourer, residing in the parish of Althorne, was said to have had a sunstroke in the harvest field on *September 10th*. He fell down on the ground, and is stated to have been insensible (? in a state of syncope or collapse) for an hour. He is further stated to have got wet through, from remaining on the ground during a sharp shower. A medical man was not called to see him till September 14th. At that time he was found to be suffering from violent pains in his head, with spasm of the muscles of the back and neck; there was well-marked retraction of the head, with loss of power in the lower limbs. He had fever. Coma supervened, and he died on September 23rd. The case was notified *after death took place*, as typhoid fever. From the history, however, there appears to be little doubt that the man died from cerebro-spinal fever.

Two other fatal cases of doubtful typhoid were carefully inquired into by Dr. Thresh, but owing to a number of difficulties connected with the investigation, it was not found possible to obtain full histories of these cases. But so far as it went the inquiry in each case showed that the death was very possibly not due to typhoid fever, although the disease had in each instance been notified and certified as such. Both patients were suddenly attacked, and died respectively four and ten days after invasion. In this connexion Dr. Thresh sends me notes of two non-fatal cases in one family in the same locality, one of which was notified as "typhoid."

A boy, aged 4, was taken ill suddenly on *July 15th*, out of doors; he was thought to have had sunstroke; he complained of his head. His face was said to have been "cyanotic." Next day he had a "fit." A medical man was sent for and diagnosed the case as "typhoid." But there were no definite symptoms of typhoid fever. No reasonable cause could be discovered for the origin of the case. A fortnight later the mother of the child informed Dr. Thresh that another child had been attacked in the same way, but had also recovered. The medical man in question, who attended the first case, saw the second one also, but he did not notify it as typhoid. When written to regarding the possibility of cerebro-spinal fever having been the disease from which these children suffered, he did not give the clinical details of the cases.

## Lincolnshire (*Willingham*).

*Willingham* (*Willingham-by-Stow*), in the Gainsborough Rural Sanitary District, is a parish 5½ miles S.E. by S. of the town of Gainsborough. It has a population of about 500, and its area is 2,170 acres.

*Willingham, 1 case.*

The particulars of a case here were given to me by Mr. F. Sutton, the medical man resident in the parish who attended the patient.

J. E., aged 5, the son of a gipsy hawker residing in a travelling van, was suddenly taken ill on *September 4th* while the family were camping at Willingham. His illness began with vomiting and headache, followed by severe spasm of the muscles of the neck and back, producing opisthotonos, and suggesting at first, owing to the tetanoid symptoms, a suspicion of strychnia poisoning. There was delirium and great difficulty in breathing. Mr. Sutton says there was also pneumonia. The boy died on September 6th in convulsions, his illness having lasted only 56 hours. The death was certified as due to pneumonia, but Mr. Sutton on further consideration now regards the case as in all probability one of cerebro-spinal meningitis. He did not know whence the family came, nor whither they went after leaving Willingham. No post-mortem examination was permitted.

### *Holbeach.*

*Holbeach* (in the Urban Sanitary District of Holbeach) is a small town, having rather more than 2,000 inhabitants, in the south of Lincolnshire, 8 miles E. by N. from Spalding. Mr. R. R. Harper, a medical man practising in the town, mentioned the following case to me, as having recently occurred in his practice :—

*Holbeach U.S.D., 1 case.*

S. G., aged 41, wife of a horsebreaker in poor circumstances, residing in Holbeach, became suddenly ill on *October 30th*, with headache and increasing pain in the neck and back. The neck became stiff and the head retracted. She had frequent jerking of the limbs, and she suffered from frequent attacks of intense fear. She complained that her legs were dead; movement in them was impaired. Later on her legs became rigid. She had delirium and fever, the highest temperature noted was 102°·5. Her cheeks had "a mottled purply" look, and there were patches on her face. She died in convulsions on the ninth day of her illness (November 7th). She had been subjected to privation previous to her illness, and was badly nourished. Her husband, a drunkard, suffered from epilepsy. No post-mortem examination was permitted. Mr. Harper does not know of any similar case in the locality, nor of any cases which might have been due to milder manifestations of the disease.

### *Gedney Hill.*

*Gedney Hill* is a hamlet-chapelry in the Rural Sanitary District of Holbeach. It lies 10 miles west of the town of Holbeach, and is a few miles from the borders of Cambridgeshire. The population is under 400. Much of the land is reclaimed fen. Dr. Crowden, the resident medical man, took me, during a recent visit to the locality, to see a convalescent boy, who was considered to have been suffering from an attack of cerebro-spinal meningitis.

*Gedney Hill 1 case.*

W. L., aged 5, the son of a farm labourer, was taken ill on *November 5th*, with headache, vomiting, pain in the back and neck. His head became retracted, he had constipation, delirium, and attacks of screaming. There was some loss of power in the legs. His mother said the boy seemed very sensitive, and cried out when touched. When I saw him on November 13th he was sitting up for the first time. On the previous day he had developed a running from his ears, and there was some deafness. The boy was at school on the day his illness began. Dr. Crowden had heard of no similar cases in the neighbourhood. Another medical man had seen the case with Dr. Crowden, and both came to the conclusion that the case was one of cerebro-spinal meningitis, though neither had seen a case of the kind before in their medical experience.

[Some 20 miles S.W. of Gedney Hill is the village of Elton, on the borders of Huntingdon. In this village, I was informed by Mr. Elliot, of Oundle, that two cases of cerebro-spinal meningitis occurred in his practice in July 1889, in two different families. The one case was that of a child, aged 12 months, who was attacked on July 23rd, and died on the 27th. The other was also the case of a young child, taken ill on August 6th, but who recovered. Both cases had well-marked symptoms, including retraction of the head. He traced no connexion between the two families. Mr. Elliot says he saw cases of the kind in the Dublin hospitals in 1870, and he recognised the cases at Elton at once as unmistakeable instances of cerebro-spinal meningitis.]

Table giving the Total Deaths registered from Cerebro-Spinal Meningitis in the Counties of Essex, Suffolk, Norfolk, and Lincoln, for each of the Five Years 1885 to 1889.

| —— | 1885. | 1886. | 1887. | 1888. | 1889. | Total in 5 years. |
|---|---|---|---|---|---|---|
| Essex - - | — | 1 | — | 1 | — | 2 |
| Suffolk - - | — | — | — | — | 1 | 1 |
| Norfolk - - | — | — | 3 | 1 | — | 4 |
| Lincoln - - | 1 | — | — | — | 3 | 4 |
| | 1 | 1 | 3 | 2 | 4 | 11 |

Cerebro-spinal meningitis in its epidemic form is rare in England, to judge from the literature of the subject. It was not till the epidemic in Ireland of 1866 that the malady could be said to have shown itself definitely in the British Isles, although scattered cases of a sort approximating to the epidemic disorder had been recorded from time to time. It is interesting to note that just before this (1866) a virulent outbreak of the disease had raged in North Germany in the region of the Lower Vistula. This epidemic formed the subject of a detailed report by Dr. Burdon Sanderson, and was published in the Eighth Annual Report of the Medical Officer to the Privy Council. In this report is given a full description of the clinical and pathological details of the disease. Some-

where about the time of the German outbreak, or shortly after it (*i.e.*, in 1866), cases of cerebro-spinal meningitis were reported in various localities in England. One group of such cases occurred at Rochester, and an account of these is given in Dr. Sanderson's report. Some cases of the kind are said to have been noted in London about the same time. In the "Lancet" for June 25, 1867, Dr. G. M. Lowe records an outbreak which occurred in the previous winter at Bardney, a rural village 10 miles south of Lincoln. In recent years cases have been reported: for example, in 1886 Dr. J. Irvine Boswell, Medical Officer of Health for the Urban Sanitary District of Faversham, recorded two deaths occurring in one family from this disease within 24 hours of each other in Faversham. In the "Lancet" for July 14, 1888, two fatal cases are published; they occurred at the Seaman's Hospital, Greenwich. Both patients were foreign sailors, one a Norwegian, was admitted May 30, 1888, the other an Italian was admitted on June 8, 1888.

Dr. Trevelyan, of Leeds, is reported, in the "British Medical Journal" for November 22, 1890, to have read a paper before the Leeds and West Riding Medico-Chirurgical Society on cerebro-spinal meningitis. He speaks of post-mortem examination of seven fatal cases during the last 12 months. It is to be hoped his paper will be published *in extenso*.

The disease is known to have been appearing epidemically on the shores of the Mediterranean during 1887 and 1888, but whether the cases in the present year occurring in the east of England are connected in any way with the foreign cases there is no evidence to show.

Fatal cases, apparently unconnected with epidemics of the disease, are mentioned annually in the reports of the Registrar General. The following table gives the number of deaths registered from cerebro-spinal meningitis in England and Wales during the last five years:—

| | Deaths from Cerebro-spinal Meningitis. | | | | | |
|---|---|---|---|---|---|---|
| | 1885. | 1886. | 1887. | 1888. | 1889. | Total 5 years. |
| England and Wales. | 27 | 40 | 24 | 18 | 23 | 132 |

On examining the distribution of these deaths in the various English counties, no exceptional incidence is noticeable in any particular part of the country in any one year, except that in 1886, out of a total of 40 for the whole country, the number of such deaths in Devon amounted to 9. In 1887 the number of deaths registered from cerebro-spinal meningitis in London numbered 8.

Whether these fatal cases are in fact examples of the same disease as that observed in the epidemic cases under investigation, it is not possible here to say. The fatality from epidemic cerebro-spinal meningitis is usually very high, sometimes amounting to 80 per cent. In the German outbreak before mentioned, it was estimated that half of the patients

attacked died. The group of cases recorded in the present report as having occurred in and about Oakley, amounting to a total of 20, yielded only 2 deaths. This mortality differs, therefore, from the usual experience, in that it is comparatively small; still the serious nature of the Oakley disease is shown not only by the fatal cases, but also by the fact that some cases narrowly escaped death, and others were left with more or less marked nervous mutilation.

It is highly probable that cerebro-spinal meningitis is of more frequent occurrence than is generally held. Fatal cases are certified probably under the name of "Fever," of tubercular meningitis, or of convulsions, while non-fatal cases may be diagnosed as sunstroke, as "violent cold," or some such ailment.

## No. 14.



### On the Water Supply of Barrowby, in the Grantham Rural Sanitary District; by Dr. Parsons.

The Local Government Board having received a complaint as to the water supply of Barrowby, in the Grantham Rural Sanitary District, I was instructed to visit the place and make inquiries, and I did so on August 8th, in company with the Medical Officer of Health and Inspector of Nuisances to the Authority, also with the Guardian of the parish, and the Rector, who is an ex-officio guardian.

Barrowby is a village two miles west of Grantham. It had in 1881 a population of 807, which had declined from 869 in 1871. The inhabitants are mostly of the agricultural class. It stands in an elevated situation, the highest part of the village, near the church, being 365 feet above the sea. It is on the brow of a ridge of hills formed by the outcrop of the marlstone (middle lias), this ridge having a steep escarpment on the N.W., and a more gradual declivity towards the S.E. in the direction of the dip of the strata. The village is somewhat compactly built, the houses standing together in rows. It was sewered before the passing of the Public Health Act, 1872; the sewers are of glazed socket pipes. They have plenty of fall, and are described as being in good working order, but there is reason to believe that some of the house drains are defective. The outfall of the sewer is upon an osier bed. There are few waterclosets connected with the sewer, most of the houses having privies with deep underground cesspits, which in some cases could be seen to be constructed of dry brickwork, a construction facilitating soakage of foul matters into the subsoil.

The water supply of the village is obtained from wells, said to be about 56 in number; each block of property as a rule having its own well. The wells are of moderate depth, and they are stated to be usually 30 feet or under. The water rises in them to from 3 to 15 feet from the surface; and there appears to be no difficulty in finding a supply in any part of the village. Some of the wells are furnished with pumps; others are open, the water being drawn by a windlass. Some were seen to be so insecurely covered as to be a source of danger, *e.g.*, one at the end of Maltinghouse Yard.

The strata pierced by the wells, as far as I can learn, are 1st (below the top soil), a yellow, rubbly, calcareous sandstone, locally called "skerry"; 2nd, lias clay or shale, containing one or two bands of ironstone; 3rd, a grey rubbly rock, in which the water is found. There is water in the upper rubbly stone, where it rests on the lias clay, but the largest supply, as well as the best water, is said to be from the stone below the clay.

Mr. Harrison, well-sinker, of Barrowby, tells me that in the wells newly sunk it is the practice to make the upper part of the well, from the top of the clay upwards, watertight, with brickwork set in cement, and a backing of clay; and he thinks that if the wells were always so constructed there would be no difficulty in getting good water. The generality of the wells, however, are not constructed so as to exclude water from superficial sources, being steined in the upper part only with dry stone or brick work (the top courses only being set in mortar), while below the steining the sides of the well are formed only of the bare rock. In some instances dark stains were seen running down the inside of the well at its upper part. Many of the wells are

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so situated as to be in danger of contamination by privies, pigstyes, "crew-yards," &c.; in one instance, in Casthorpe Lane, the well which supplies water to a row of houses in which enteric fever has occurred, is only 9 feet distant from a privy on the next property. Another well is 30 feet from the churchyard, 21 feet from a privy, and 40 feet from a pigstye. Some of the pump wells are liable to be fouled by waste water entering the well, owing to want of a proper pump trough and drain. The water of one well has a slight sulphurous smell believed to be derived from mineral matters in the strata. The water of the wells is, however, in general nearly clear and colourless, and free from taste and smell, but on analysis that of most of the wells has shown evidence of pollution. By such tests as I was able to apply on the spot, I found that the amount of chlorine—a constituent in such a situation derived, in all probability, from house drainage—varied from 2 grains per gallon in two wells (one newly sunk) on the outskirts of the village, to 16·4, 17·5, and 21·4 grains per gallon respectively in certain wells in close relation to sources of contamination. Under the same circumstances also the nitrates varied from a small trace to a very large amount.

Samples of water from three sources were taken and forwarded for analysis to Dr. Frankland, whose report is added.

"No. 7940, Major Amcott," is from a pump in a grass field, at the south-east end of the village, with no apparent sources of sewage pollution near, though the well is insufficiently protected against the entrance of waste water spilled from the pump. It may be looked upon as a water as good as is likely to be met with near the village, from a well of the ordinary depth and construction.

"No. 7941, Green well," is from a draw well in the upper part of the village, surrounded with houses, but with no apparent sources of pollution very near. This water is much used, and is locally considered very good, but Dr. Frankland's analysis shows it to contain much oxidised sewage.

"No. 7942, Downing's pump," is from the pump in Casthorpe Lane, previously mentioned. Dr. Frankland reports it to be of "about the "same composition as London sewage after filtration through 6 feet of "porous soil."

Dr. Ashby, late Medical Officer of Health for the Grantham Rural Sanitary District, in his Annual Report for 1887, states that of the samples of water from Barrowby analysed by him during the year 13 were very bad, four were bad, two were of indifferent quality, and only one, and that from outside the village, was of good quality.

Outbreaks of enteric fever have occurred in Barrowby from time to time during past years, and have been attributed by the late Medical Officer of Health, Dr. Ashby, to the use of contaminated well water, but the present Medical Officer of Health, Mr. Eaton, does not support this opinion. A death of a boy, aged nine, certified as from enteric fever, occurred in June 1889 in the family of the schoolmaster of the Barrowby National School, and other children in the same family were ill afterwards with similar symptoms of less severity. A servant girl at the same house had been sent away three or four years ago with an illness which proved to be a severe attack of enteric fever. The schoolmaster's house stands in a garden in a fairly open situation, the drain inlet is out of doors, and the privy is well removed from the house. The source of water supply at the time in question was from a well in the garden, stated to be 29 feet deep, and furnished with a pump. This well is 40 to 50 feet from the privy of the schoolmaster's house, but only 28 feet from the cesspit privy of a neighbour. The water is stated to have been analysed by Dr. Ashby, and pronounced bad, but it remained

in use, as there was no other supply near. In July 1889, on the advice of the present Medical Officer of Health, the well was pumped out and cleansed. It is stated by the well-sinker who did the work that three or four barrowsful of mud were removed; this mud was blue clay, not offensive. There were old stains down the sides of the well all round, but no recent stain at any particular point as if from leakage from a drain. The well was lowered 2 or 3 feet, the bottom being found to be blue shale, but it was not puddled around the top. After these operations a sample of the water was sent by the rector to Dr. Stevenson, whose analysis was condemnatory. The agent of the landlord, on being communicated with, sent another sample of the water for analysis to Dr. Voelcker, and his report being also unsatisfactory the well was ordered by the Rural Sanitary Authority to be closed. The pump has since been removed, but no other supply has been provided, and water has now to be fetched from the "Green well," some 100 yards distant. This Green well is one of the wells of which the water has been analysed by Dr. Frankland for the purpose of this report, and is reported by him to consist chiefly of infiltrated sewage.

Mr. Eaton, however, doubts whether the case of the schoolmaster's son was one of enteric fever, and thinks that, if it were, the cause is to be found rather in the state of the school privies than in polluted drinking water. It is admitted that the privy on the boys side at the school (which is near, but not closely contiguous, to the schoolmaster's house) was at that time in a foul state, and the boy sometimes used it. It would, however, be expected that if the cause of the boy's illness existed at the school, and not at the schoolmaster's house, other children in the village who attended the school would have suffered. There are stated to have been two other cases of enteric fever in Barrowby in 1889 subsequent to that of the schoolmaster's son, one a boy in Chapel Court, in a different part of the village; another, an infant at the breast. I heard of other cases in 1888, 1886, and 1885. The circumstances of the cases in 1889 gave rise to a prolonged controversy, which it is perhaps not necessary to revive. Whatever may have been the nature or cause of these particular cases, there appears to me to be no room for doubt, from the concurrent testimony of various analysts, from the construction and position of the wells, and from the repeated occurrence of outbreaks of enteric fever in the village, that the present water supply is a source of danger to the health of the inhabitants.

Dr. Ashby in 1886 made a report to the Rural Sanitary Authority on the water supply of Barrowby, of which I annex a copy.* As alternative sources of supply, he proposed, first, a well on the high ground west of Barrowby; and secondly the Sheep Dyke spring, about a mile from the village; but in a subsequent report he gave eventually the preference to a third source—the Mires spring, 2 miles south-east from the village—on account of the ampler yield of water in dry weather. Any one of these schemes would involve pumping, which it was thought might ordinarily be done by wind power. The question of the water supply of Barrowby was considered at a meeting of a parochial committee on September 21st, 1887, when a resolution to employ an engineer was lost, and a motion was carried recommending the Rural Sanitary Authority to take the necessary steps to enforce the cleansing of all the polluted wells. This course was ratified by the Rural Sanitary Authority, and since then no further action has been taken with respect to the water supply of Barrowby beyond the occasional cleaning out of an old well or the sinking of a new one.

* Not here reproduced.

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I may point out that if a well be found to be polluted with organic matter, merely to clean it out is a very futile proceeding. What is required is so to construct the well as to exclude polluting matter from entering it, and if this cannot be done the well should be closed. Where the water-bearing bed lies under an impervious bed of clay, the polluted top-soil water should be excluded by making the well watertight as far down as the clay bed. A way of doing this, which has been successfully adopted in some districts, is to use for steining the well, large-sized glazed socket pipes, such as are used for sewers, but set vertically and with the joints securely caulked. For this purpose pipes are sometimes made with the flanges inside. The same object may in some districts be attained by the use of Abyssinian tube wells.

But where there is a general pollution of the water-bearing bed, as would appear from the analyses which have been made to be the case at Barrowby, the only safe course is to obtain a supply from an outside source, free from the risk of contamination.

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## ADDENDUM.

Water Analysis Laboratory, The Yews,
Reigate, August 15, 1890.

Sir,

Herewith I enclose results of analysis of three samples of water sent here by the direction of the Medical Officer of the Local Government Board in connexion with an inquiry as to the water supply of Barrowby.

The sample labelled "Major Amcott's" is the only one which could be used for dietetic purposes without great risk to health; but even this sample exhibits considerable evidence of previous sewage contamination, and, unless, derived from a spring or deep well, should be condemned as unfit for human consumption.

The remaining samples consist chiefly of infiltrated sewage, that labelled "Downing's pump" having about the same composition as London sewage after filtration through 6 feet of porous soil.

All the samples are hard and unfit for washing.

I am, Sir,
Your obedient servant,
(Signed) E. Frankland.

The Secretary,
Local Government Board.

Results of Analysis expressed in Parts per 100,000.

| Number of Sample. | Description. | Solid Total Matters. | Organic Carbon. | Organic Nitrogen. | Ammonia. | Nitrogen as Nitrates and Nitrites. | Total Combined Nitrogen. | Previous Sewage or Animal Contamination. | Chlorine. | Hardness. | | | Remarks. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | Temporary. | Permanent. | Total. | |
| | Barrowby, August 8, 1890. | | | | | | | | | | | | |
| 7940 | Major Amcott's - | 43·12 | ·121 | ·030 | 0 | ·433 | ·463 | 4,010 | 3·0 | 15·4 | 10·6 | 26·0 | Turbid. |
| 7941 | Green well - - | 78·80 | ·134 | ·061 | 0 | 2·436 | 2·497 | 24,040 | 5·3 | 27·3 | 6·3 | 33·6 | Turbid. |
| 7942 | Downing's pump, Casthorpe Road. | 173·20 | ·277 | ·064 | 0 | 7·118 | 7·182 | 70,860 | 23·0 | 22·9 | 55·3 | 78·2 | Slightly turbid. |

E. Frankland,
The Yews, Reigate.

## No. 15.

### On an Outbreak of Fever at Northop Hall in the Holywell Rural Sanitary District; by Mr. Spear.



The hamlet of Northop Hall consists of three or four rows of cottages with several single dwellings situated at wide intervals by the roadside; the total population being estimated at between 400 and 500. The geological formation is that of the Lower Coal Measures, and the surface soil is clay and clayey loam and shale. A small colliery on the outskirts affords some employment, and, for the rest, the population is mainly employed in agricultural pursuits. The cottages are of a poor class—small and badly ventilated, and occasionally damp from dilapidation; many are very fully occupied if not actually overcrowded. As regards the maintenance of cleanliness, the hamlet is described by the Medical Officer of Health and Inspector of Nuisances as the one of all others in the district giving the most trouble. The inhabitants have, in fact, little opportunity of acquiring habits of decency and cleanliness. There are no proper means of drainage. Liquid sewage is allowed to flow for the most part into the roadside gutters, or collects in pools outside the dwellings; solid filth is deposited in dilapidated and foul privy-pits, which are rarely emptied, and the oozings from which are occasionally to be seen even on the surface. Water has often to be fetched by hand from quite unreasonable distances, and is only then procurable from dip-wells or roadside troughs, doubtless more or less liable to surface contamination.

The fever that invaded this little community during the earlier months of the present year was undoubtedly typhoid or enteric fever, although its apparent mode of extension had suggested the possibility of its being typhus. The clinical histories of the earlier cases were in the main characteristic of the first-mentioned disease; in some of the later ones that I had an opportunity of seeing myself, the characteristic eruption of typhoid, in addition to other distinguishing symptoms, was apparent.

Between February and the end of June 1890, seven households were invaded—three in New Brighton Row, one in Dublin Row, and three amongst the scattered roadside cottages. In all there appear to have been 18 unequivocal cases, and four deaths. Another fatal illness, in one of the infected families, had been popularly ascribed to the fever, but the death was not so certified by the medical attendant. All the deaths (including the one just referred to of doubtful cause) occurred amongst the members of one family, although in two households.

The cases seem all to have been connected. The first one of the series occurred in the month of February, in the family to which the disease proved afterwards so fatal. The sufferer, a lad, aged 14, worked in the lamp-room of the neighbouring colliery. The origin of his infection could not be discovered, although it may be remarked that three cases of enteric fever (one of the sufferers being a colliery worker) are reported to have occurred in the village during the preceding year. The household now invaded consisted of five persons: the father, aged 54, and four children aged from 14 to 28. One of the daughters contracted fever some six weeks after the lad's attack above referred to, and then, in quick succession, the others were infected. The father and two daughters, aged respectively 21 and 25, died.

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On Fever at Northop Hall in Holywell R.S.D.; by Mr. Spear.

When all the members sickened, this family was reduced to a condition of much distress; proper attention and nursing, and, as matter of course, proper regard to precautionary measures of disinfection, &c., being wanting. Under these circumstances a focus of infection was evidently set up, from which the disease was disseminated. In the second week of May, two children of a woman who had taken linen and bed clothing from the infected house to wash at her own home, sickened of the disease; and about the same time a married daughter and son-in-law, living in another part of the village, who had assisted in a certain measure their fever-stricken relatives, fell ill. Then in the first week of June, three children of a woman who had been employed occasionally during the day in nursing at the first infected house, were attacked. I was told that these children were often seen in the infected house itself while their mother was employed there, and that they had often been given food and drink on the infected premises. Their own house was dirty and overcrowded, and the disease spread there to three other children, so that at the date of my visit six children of the family were lying ill.

Three other families in the village were infected, single attacks only, up to the dates of my visit, July 4th and 5th, occurring in each of these cases. In each one it was found that the patient had been closely exposed to sewage effluvia arising from the premises of persons previously attacked.

There was no community in the milk supply of the infected families, that being obtained from three distinct sources. As to the water supply, the family first invaded obtained theirs from the Reid's spring, an open dip-well said to be much contaminated at the time by decayed vegetation, but apparently removed, as far as an open dip-well in a frequented path-way can be, from opportunities of excremental contamination. Three of the infected families obtained their supply from this source, the others resorting to a similar spring by the roadside, half-a-mile or more away. It cannot be said therefore that there was community of water supply.

The serious spread of fever in the village is probably to be attributed to conditions already spoken of; the absence of any proper means of excrement and sewage disposal, and, in great part, to the helpless condition into which the first infected family fell when all the members were attacked. Some of these early cases were attended by much diarrhœa. Specific contamination of the air in and about the infected dwelling was no doubt considerable, and the resulting mischief would probably have been greater had it not been that most of the neighbours were too terror-stricken to come near. At the time of my visit a trained nurse had been provided by private charity. She was quartered in the village, and evidently rendering much valuable and highly appreciated assistance to the fever-stricken families. The condition of things still, however, pointed strongly to the necessity which exists for a hospital for isolation in such cases. As I have said, in one house six children are lying ill of the fever. They occupied two small bed-rooms in common with their parents, and in each of three beds (one of these improvised since the nurse's arrival) there were two sick children. It was most deplorable to see in each bed an exhausted and prostrate child, just out of the acute stage of the fever, with quietude and rest rendered impossible by the tossing and raving of its still delirious bedfellow. One of the children, I noticed, was covered with bruises—a condition explained as resulting from its having frequently fallen out of bed when delirious. As to the danger, moreover, of such a condition of things to the community, I found that, in the nurse's absence, and notwithstanding

the warnings of the Medical Officer of Health and Inspector of Nuisances, the half-distracted mother was disposing of the discharges of the fever patients by simply throwing them on to the nearest available space about the dwelling. About the dwelling, too, were little pools of slop water from the washings of infected clothes.

I was informed that the Authority, acting under the advice of the Medical Officer of Health, had now the question of hospital provision under serious consideration, and it was anticipated that the necessary action would be immediately taken. This step, together with the provision of proper means for the removal of sewage and house refuse, the provision of a sufficiently accessible water-supply, and its protection against surface pollution, and the careful abatement of nuisances arising from ill-ventilated and dirty dwellings, is urgently needed.

## No. 16.

App. A. No. 16.

On the Sanitary Condition of Wells, Norfolk; by Mr. Spear.

### On the Sanitary Condition of the Wells Urban Sanitary District Norfolk; by Mr. Spear.

The Urban Sanitary District of Wells-next-the-Sea is situated near the north Norfolk coast, communication with the sea, some mile and a half distant across marshes, being by the "Wells Channel." The population is estimated to be in number much the same as at the time of the 1881 census, viz., 2,645; and the industries are those connected with agriculture, malting, a little shipping, and fishing. During the summer season there is some influx of visitors; as many as 200 may, it is estimated, be at one time in the town.

The little town stands on land that gradually rises from the "channel," and the marshes, on the north, to an elevation of some 25 feet above datum, and which then falls again to the south to a level of some 12 feet. The geological formation is that of the upper chalk; the chalk being very near the surface in most places, in others capped by gravel and sand deposits, or overlaid, in a strip of land on the southern border of the town, by brick earth.

The main streets of the town are narrow, so that there is no room in the greater part of their length for a paved footway. Courts are numerous, especially about the quay, or channel front, on to which many open. Dampness of houses, owing probably to the porosity of the soil, is not conspicuous; although many of the houses are very old and not possessed of through ventilation, while the surface of courts and yards is often unpaved, or paved only in a rough and imperfect way. The cottages themselves are generally neat and clean.

In the drainage of the town advantage has been taken of the natural contour of the ground already described. Some two-thirds of it drain northwards by sewers which open into the sea channel, or, as on the western extremity, into a dyke, which itself later discharges into the channel. The remaining third, or southern portion of the town, is drained in an opposite direction, the sewers here discharging into what is described in old maps as "the old public drain." This latter, which probably marks the bed of an ancient watercourse, has now, throughout the greater part of its length, been culverted; it discharges into a dyke which, after a circuitous course through the marshes, finds an outlet into the sea channel. In the dyke on the western extremity of the district, before spoken of, as also in the unculverted portion of the "old public drain," sewage stagnates to some extent so as to cause a nuisance. The attention of the authority is now being directed to this matter.

The sewers of the town consist partly of old brick culverts and partly of socketed pipes of more modern construction. Man-holes and surface ventilators have not been provided, but the gradients are said to be good, and the sewers consequently fairly free from deposit. Flushing, when required, is effected through the roadside gullies.

Ventilation, if so it may be called, is imperfectly provided for by the rain-water spouts of houses only. The drain connexions on private premises are often imperfect; in many cases drains are of the old rough brickwork, while yard-gullies are in many cases untrapped, or still more often protected by the bell-trap only. There are very few, if any, waterclosets connected with the public sewers.

The authority have secured the abolition of the great majority of cesspools and privy pits with which the town was at one time liberally provided. The former have been filled up, and the slop-water drains connected with the sewers, while for the privy pits cemented "tanks," as they are called, occupying the space below the closet seat only, have been substituted. These receptacles are believed to be water-tight and are sunk, if at all, only a few inches below the surface of the ground. The authority do not provide for their emptying, but owners or occupiers may secure the periodical visits of private scavengers at a stated charge. By this agency it is usual for the "tanks" to be emptied either at weekly or fortnightly intervals, although there is occasional neglect. Of the old deep privy pits there are believed to remain now not more than 20 or 30 in the town.

The authority have paid considerable attention to the drainage of premises, and have enforced the use of small water-tight privy receptacles, largely with a view to the protection of the water supply; for this is derived exclusively from local wells. The latter are very numerous, for every court or "yard" has its well and pump, and, in the front streets, almost every house. The wells vary in depth from 10 to nearly 40 feet, according to their position, but are invariably carried into the chalk. The sides are steined with brickwork down to the chalk, and in most cases now the well is arched over with masonry and provided with a pump. The water is said to fall low in summer but never to fail entirely. Along a belt of the foreshore, facing the quay or sea channel, the wells become dry during the lowest tides, but with the flowing tide the springs are held up again.

Pure water was hardly to be expected from shallow wells sunk in a soil that had been occupied by human beings for ages, in yards that were often unpaved and very close to privies and drains which have only in recent years, if even now, been made water-tight, and analysis confirms this view. Samples of water, taken from wells on the south, in the centre, and on the north of the town, were sent to Dr. Frankland for analysis, and are all classed by him as "dangerous." Of the several samples, that from the southernmost well shows much the least amount of "previous animal contamination," although it was the only one of the three close by a deep uncemented privy pit. Its comparative freedom from pollution is perhaps due to the fact that it is one of those wells influenced by the tide, and that by the free rise and fall of the water the soil around is washed more clean. It had been dry on the morning of the day on which the sample was taken. (For analyses *see* Addendum.) The question of providing Wells with a general water service is one that has not yet been seriously considered by the authority; although the practicability of sinking a public well at the higher central and

open part, near the "Butt Lands," lifting the water to a tank tower and thence distributing it by gravitation, has been informally spoken of, I understand. To obtain water solely by gravitation from any source outside the town would necessitate, it appears, transit from a very considerable distance; but on this point no actual investigation has been made.

Acquiescence of the authority in the present condition of the town as regards water supply expresses, it seems, the popular sense of the general wholesomeness and sufficiency of the well water. Usually the inhabitants state that their wells afford a good and sufficient supply of water, and when turbidity after rain is spoken of, as it occasionally is, such turbidity is referred to some accidental defect (in the covering of the well, and so on), leading to the immediate percolation of surface impurity. Fuller consideration of the whole circumstances of water supply—the long sustained liability of the soil to pollution, the shallowness of the wells, the porosity of the soil, &c. (circumstances already referred to), as well as the results of chemical analysis—indicates a necessity for reconsideration of this doubtless too favourable estimate.

Locally it is maintained that the town has been on the whole very free from typhoid fever, or other disease peculiarly associated with polluted water supply. But at least one considerable prevalence of typhoid fever has occurred in recent years. This was in the autumn and winter of 1884 and the spring of 1885, when, of a considerable number of cases, four proved fatal. The Medical Officer of Health showed that the original focus of infection in this outbreak was established in the locality of a well that was afterwards found to be polluted, amongst the people using its water. This danger—the establishment of foci of infection around any introduced case of typhoid fever by reason of the specific contamination therefrom of the soil and so of neighbouring wells—is the very one which, both from experience and on *a priori* grounds, is to be regarded as particularly associated with the conditions of water supply such as are here in vogue.

The mortality returns of the district since 1884, as given by the Medical Officer of Health, are given opposite.

The dairies, cowsheds, and milkshops of the district are not registered, but are inspected. Those that I visited were, with one exception, fairly clean: but further facilities for the drainage of the cowsheds are required, and more attention should be paid to the paving of the surface of the yards. Two of the three samples of water taken for analysis were obtained from wells used by dairymen amongst others.

The slaughter-houses are not licensed. The two that I visited required further surface paving and drainage.

The only place used as a common lodging-house in the town is a licensed public-house. The ventilation of the bedrooms here is insufficient.

The authority possess no byelaws. The want of byelaws for the regulation of building is occasionally felt; as also for the regulation of slaughter-houses, the keeping of animals, &c.

The Urban Sanitary Authority act as a port sanitary authority for a district formed out of the Port of Lynn. Occasionally a foreign ship, from Riga chiefly, comes up the channel to Wells, and a place has been appointed for the mooring of any ship found to be infected. The authority possess no hospital for the isolation of infectious cases.

The Medical Officer of Health receives a salary of 20*l.* He inspects the district from time to time with the Inspector of Nuisances, and reports to the authority. The Inspector of Nuisances is an active officer and has done much useful work as his reports show. He receives the quite inadequate remuneration of 10*l.* per annum.

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Vital Statistics: Wells-next-the-Sea Urban Sanitary District.
(Population, in 1881, 2,645.)

| Year. | Births. | Total Deaths. | Deaths under one Year. | Deaths from various Causes. | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Small-pox. | Measles. | Scarlatina. | Diphtheria. | Croup. | Whooping Cough. | Fever. | Diarrhœa. | Puerperal Fever. | Rheumatic Fever. | Phthisis. | Bronchitis and Pneumonia. |
| 1884 - - | 68 | 64 | 14 | – | – | – | 2 | 1 | – | 2 | 3 | 1 | – | 10 | 7 |
| 1885 - - | 67 | 48 | 8 | 3 | 2 | – | – | – | 4 | 2 | – | – | – | 1 | 9 |
| 1886 - - | 69 | 50 | 9 | – | – | – | – | – | – | 1 | 2 | – | – | 3 | 7 |
| 1887 - - | 67 | 60 | 7 | – | – | – | – | – | – | 1 | – | – | 1 | 3 | 12 |
| 1888 - - | 55 | 47 | 3 | – | – | 1 | – | – | – | 1 | 2 | – | – | 5 | 4 |
| 1889 - - | 85 | 30 | 4 | – | 1 | – | – | – | – | – | – | – | – | 3 | 4 |
| 1890 - - | 56 | 36 | 9 | – | – | – | – | – | 4 | – | 1 | – | – | 3 | 8 |

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## ADDENDUM.

### Wells (Norfolk) Waters.

Sir,

Herewith I enclose results of analyses of three samples of water from local wells sent here for investigation.

All these waters are very hard and contain a large amount of saline constituents.

The proportion of organic matter actually present in No. 1 is not large, and it is smaller than usual in Nos. 2 and 3; but all the waters are derived from very impure sources. Indeed Nos. 1 and 3 are little better than purified sewage. They are all dangerous waters, unfit for dietetic use and too hard for washing. No. 2 is the least dangerous of the three.

I am, Sir,

Your obedient servant,

(Signed) E. Frankland.

The Secretary,
Local Government Board.

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## Results of Analysis expressed in Parts per 100,000.

| Number of Sample. | Description. | Total Solid Matters. | Organic Carbon. | Organic Nitrogen. | Ammonia. | Nitrogen as Nitrates and Nitrites. | Total Combined Nitrogen. | Previous Sewage or Animal Contamination. | Chlorine. | Hardness. | | | Remarks. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | Temporary. | Permanent. | Total. | |
| 7996 | *No. 1, Wells, Norfolk, 8th Nov. 1890. | 76·20 | ·162 | ·034 | 0 | 2·784 | 2·818 | 27,520 | 7·0 | 32·9 | 15·0 | 47·9 | Turbid. |
| 7997 | †No. 2 „ „ | 49·08 | ·079 | ·029 | 0 | 1·376 | 1·405 | 13,440 | 5·4 | 23·4 | 8·1 | 31·5 | Slightly turbid. |
| 7998 | ‡No. 3 „ „ | 92·52 | ·083 | ·022 | 0 | 4·853 | 4·875 | 48,210 | 11·1 | 25·3 | 19·7 | 45·0 | Turbid. |

E. Frankland,
The Yews, Reigate.

* No. 1.—Well and pump belonging to dairy and four cottages on south side of town (Church Street). Shallow in chalk; about 10 feet from cow-yard; 14 feet from dilapidated drain gully. About 20 feet off, on other side, small water-tight privies, converted about two years ago, from privy vaults. Water said to be temporarily discoloured after rain.

† No. 2.—Well and pump belonging to dairy premises in Freeman Street, near the quay (north side of town). Shallow well in chalk, about 10 feet from deep privy vault. Well dry when tide exceptionally low, as on the morning of the day when the sample was collected. No complaint as to the quality of the water.

‡ No. 3.—Draw well behind top of High Street (the central and highest part of town). About 30 feet deep, with about four feet of standing water; walls steined with bricks to level of chalk. Privy vaults and bad drains, within a few feet of the well, removed seven years ago; cemented privy receptacles and pipe drains substituted. No complaint from the several families using the water.—J. S.

## No. 17.

### On the General Sanitary Circumstances and Administration of the Rawdon Urban Sanitary District; by Dr. Barry.



The inquiry to which the following report (June 1890) refers was directed to ascertain the general sanitary circumstances and administration of the Urban Sanitary District of Rawdon, with respect to which complaints had from time to time been made to the Board of default by the Sanitary Authority; and of which the Board could learn nothing from the reports of the Medical Officer of Health.

*General Description.*—The Urban Sanitary District of Rawdon comprises an area of 1,559 acres. It is roughly triangular in shape, and is bounded on the south by the River Aire, and on the west and east by the Yeadon and Horsforth Urban Sanitary Districts respectively. The district is situated altogether within the watershed of the River Aire, and from its highest point at Billing Hill (700 feet above Ordnance datum) the surface slopes westward to Yeadon, southward to the River Aire (here 200 feet above Ordnance datum), and eastward to the beck dividing Rawdon from Horsforth. There are three aggregations of houses in the district: (*a*) at Rawdon proper, which is situated nearly in the centre of the district, to the north of the Leeds Road at an elevation of some 400 feet above the river; (*b*) at Little London, a compact cluster of houses abutting on the Yeadon boundary, directly west of Rawdon but some 100 feet below it; and (*c*) at New Road Side, Little Moor, and Canada, comprising several straggling rows of houses, situated also near the Yeadon boundary, but a little to the north of Little London and at a slightly higher elevation. The southern portion of the district, known as Crag Wood, between the Leeds Road and the river is thickly wooded and sparsely inhabited; it contains a number of mansions of Bradford and Leeds manufacturers.

The subsoil consists of sandstone at Little London, and chiefly of clay overlying the sandstone at Rawdon, New Road Side, and Little Moor.

The population in 1871 was 2,796, and in 1881 3,047 living in 660 houses. At the present time the population is estimated at 3,500. The gross rateable value is (1890) 14,271*l.*, and the assessable value 11,768*l.*

There are two woollen mills in the district which employ a number of persons, and several small dairy farms whence milk is sent to Leeds and Bradford.

Before entering on description of the sanitary circumstances of the district, it will be useful to give a brief account of the events which led to, and which followed upon, the formation of the township of Rawdon into a separate area of local government. From 1872 to 1879 the township of Rawdon was comprised within the Wharfedale Rural Sanitary District. In 1877 the Rural Authority, having received complaints of the existence of nuisances due to the want of sewers in different parts of Rawdon, proposed a scheme for the drainage of the township with the exception of the Crag Wood Estate. Hereupon the inhabitants immediately petitioned the Local Government Board to form the township of Rawdon into a Local Government District. The Board, upon the receipt of this petition early in 1879 directed local inquiry to be held thereon by their inspector Mr. Morgan. At the inquiry it was stated that the Rawdon ratepayers particularly wished (*a*) to have control of

the sewerage,* and (*b*) to have jurisdiction over the erection of new buildings in their township; and as a result the Board assented to the separation of Rawdon from the district of the Rural Sanitary Authority, and, in an Order dated June 10th, 1879, sanctioned the appointment there of a Local Board.

In 1883, four years after the formation of the Local Board District, a complaint by a resident was lodged with the Board under sect. 299 of the Public Health Act, 1875, that the Local Authority of Rawdon were in default in providing their district with proper sewers. At an inquiry held by Mr. Codrington, under direction by the Board, on the 18th January 1884, this allegation was sustained, and in due course the Sanitary Authority were declared in default. As the Local Authority took no steps to remedy the defects complained of, the Board wrote on September 2nd, 1884, to the Sanitary Authority and informed them that they proposed to direct further local inquiry with a view to dissolving the Local Board. Upon receipt of this letter the Sanitary Authority engaged an engineer to prepare a scheme of sewerage for the district, and on October 31st made application to the Board for a Provisional Order to enable them to purchase land for the purposes of sewage disposal. After inquiry as to this application, held by Mr. Codrington, February 25th, 1885, a Provisional Order was issued to enable the Rawdon Urban Sanitary Authority to put in force the compulsory clauses of the Land Clauses Consolidation Act, and this Order was confirmed by Act of Parliament in July of the same year. In January 1886 the Local Board asked sanction of the Local Government Board to borrow 10,000*l.* for works of sewerage and sewage disposal, and after public inquiry held by Mr. Codrington sanction was given on April 6th, 1886, to the Rawdon Local Board to borrow 8,220*l.* for the construction of the necessary works. In 1887 complaint was made to the Board that nothing had been done to improve the drainage of the district. In answer to a letter which the Board addressed to the Local Authority on this subject, it was stated that nine-tenths of the inhabitants were against the carrying out of the complete scheme for which loan had been sanctioned, but that the Sanitary Authority were then engaged in constructing a sewer which would drain the complainant's property to his satisfaction.

*General Sanitary Circumstances.*—In describing the general sanitary circumstances of the district I propose to deal first with the results of the control obtained 11 years ago by the inhabitants over the sewerage and over the erection of new buildings in the district: a control sanctioned for the professed purpose of duly regulating these matters.

*Sewerage and Drainage.*—The sewerage is of a piecemeal and makeshift character. At Rawdon proper the house slops are discharged into roadside channels, and thence are conveyed on to land, where, if it suits the convenience of the farmer, they are utilised; if not, they pass down by means of ditches to the beck which forms the boundary between Horsforth and Rawdon, and which has its outfall into the River Aire. I understand that a field has recently been rented by the Sanitary Authority upon which some of this sewage is to be utilised. At Little Moor and New Road Side, pipe sewers have been laid by the Sanitary Authority which have at present, as matter of fact, an outfall

* In connexion with this contention it is interesting to note the following minute made at a vestry meeting held on October 10th, 1878, prior to the inquiry; it runs as follows:—"From what has passed it appears that we are powerless in opposing "the expensive drainage scheme favoured by the sanitary authority, it was there-"fore proposed and seconded that a Local Board be formed for managing the affairs "of the town of Rawdon without further delay. Carried with only one dissentient."

into the sewers of the Yeadon Local Board. As, however, the Rawdon Local Board have failed to come to any agreement with Yeadon, the latter Authority have resolved to sever this sewer connexion, and the consequence will be that the sewage of this portion of the Rawdon district will pass directly into the streams of the Yeadon district. The pipe sewers above referred to are those constructed in 1887 with reference to a particular complaint then before the Local Government Board. They are provided with gratings in the centre of the road for ventilation, but are not furnished with manholes nor with any special means for flushing. The slops from a row of 50 cottages known as "Canada" are discharged into the Slack Beck, which passes through the Yeadon district to the River Aire. At Little London the slops are discharged into the old highway drains, which are stated to be constructed of loose rubble. These drains have an outfall on land comprised within the Esholt Hall Estate, where the sewage is stated to give rise to considerable nuisance. At the time of my inspection the representative of the landowners through whose property this sewage passes made formal complaint to me of nuisance thus arising. The drainage from the Larkfield Mill (situated in the upper part of Rawdon), which consists of suds and dye water, passes by means of an open channel through the Crag Wood Estate to the Aire. This channel receives also the house drainage of some dwellings at Low Green. The drainage of Low Mill, which consists largely of sud water and the refuse from sud tanks, is discharged directly into the River Aire. It is stated that none of the drains above noticed, with the exception of the sewers which have outfall into the Yeadon sewers, receive anything but slop water. The large residential houses at Crag Wood are stated to be furnished in every instance with cesspools.

The house drainage in the case of the older houses is generally most defective. In many instances the house drains are constructed of loose rubble only, and slopstone pipes in this class of property, as for example in Little London, are almost invariably in direct communication with the faulty sewers. In the case of new houses disconnexion of the sink-pipes has apparently been carried out, but some cellars have been directly drained to the sewers. In some houses in Nether Yeadon, Rawdon, drains constructed of rubble pass directly under the houses. No attempt has, I understand, anywhere been made by the Local Board to secure the proper ventilation of house drains.

From the above it will be seen as regards sewerage that, with the exception of the construction of a pipe sewer for the purpose of silencing a particular complainant, no attempt has been made by the Sanitary Authority to provide for the pressing needs of their district.

*Dwelling Accommodation.*—The dwellings as a rule are built of stone. In Rawdon proper the houses situated on the Rawdon Estate have generally a dilapidated and neglected appearance, and several of them are at the present time unoccupied. A considerable number of the houses are built back-to-back, and even where this is not the case, ventilation of houses is frequently defective. Some of the houses in Rawdon were observed to be damp from want of eave spouts and proper surface drainage, and throughout the district little attention appears to have been paid to the paving of yards. Since the formation of the Local Board several houses have been built at Little London and Little Moor, and at the present time there are in this part of the district other houses in course of construction. These I inspected for the purpose of ascertaining the results of that local supervision so earnestly desired at the time when the Local Board was formed, and in furtherance of

which a code of byelaws for the regulations of new streets and buildings was allowed by the Local Government Board on February 5th, 1881.

The nature of the supervision and control exercised by the Sanitary Authority in this matter will be best illustrated by placing in parallel columns (*a*) the text of some of the more important of the byelaws, all of which were based on the Board's model, and (*b*) the state of things actually existing in the case of buildings newly erected or in process of erection.

*Provision for securing Dryness of Walls.*

| (a.) *Byelaws.* | (b.) *Actual state of things.* |
|---|---|
| 16. Every person who shall erect a new building shall cause every wall of such building to have a proper damp course of sheet lead, asphalte, or slates laid in cement, or of other durable material impervious to moisture, beneath the level of the lowest timbers, and at a height of not less than *six inches* above the surface of the ground adjoining such wall. | Damp-proof course absent. It is stated that the provision of damp-proof course in the case of small houses has never been enforced in the district. In certain houses in course of erection the cellars were observed to contain a quantity of water, and the walls to be damp considerably above the ground level. |

*Provision for preventing Fires.*

| (a.) *Byelaws.* | (b.) *Actual state of things.* |
|---|---|
| 25. Every person who shall erect a new building shall cause every party wall of such building to be carried up *nine inches*, at the least, in thickness:<br>(i.) Above the roof, flat, or gutter of the highest building adjoining thereto to such height as will give, in the case of a building of the warehouse class or of a public building, a distance of at least *three feet*, and in the case of any other building a distance of at least *fifteen inches*, measured at right angles to the slope of the roof, or above the highest part of any flat or gutter, as the case may be:<br>* * * * | Instead of the party walls being carried through the roof, they are frequently only carried to the level of the ceiling of the topmost storey. In no case have the particular provisions of this byelaw been carried out. |
| 31. A person who shall erect a new building shall not place the end of any bressummer, beam, or joist in any party wall of such building, unless the end of such bressummer, beam, or joist be at least *four and a half inches* distant from the centre line of such party wall. | In practice the Sanitary Authority, far from requiring a nine inch interval within the party wall between the joists of contiguous houses, has permitted such joists not only to meet but even to pass *through* party walls and to overlap one another. Moreover, the roof timbers of adjoining houses are in all cases continuous. |

*Provision with respect to the sufficiency of Space about Buildings to secure a free Circulation of Air.*

(a.) *Byelaws.*

53. Every person who shall erect a new domestic building shall provide in the rear of such building an open space exclusively belonging to such building, and of an aggregate extent of not less than *one hundred and fifty square feet*, and free from any erection thereon above the level of the ground, except a watercloset, earthcloset or privy, and an ashpit.

He shall cause such open space to extend, laterally, throughout the entire width of such building, and he shall cause the distance across such open space from every part of such building to the boundary of any lands or premises immediately opposite or adjoining the site of such building, to be not less in any case than *ten feet*.

If the height of such building be *fifteen feet* he shall cause such distance to be *fifteen feet* at the least.

If the height of such building be *twenty-five feet* he shall cause such distance to be *twenty feet* at the least. If the height of such building be *thirty-five feet* or exceed *thirty-five feet* he shall cause such distance to be *twenty-five feet* at the least.

A person who shall make any alteration in or addition to such building shall not, by such alteration or addition, diminish the aggregate extent of open space provided in pursuance of this byelaw in connexion with such building, or in any other respect fail to comply with any provision of this byelaw.

For the purposes of this byelaw the height of such building shall be measured upwards from the level of the ground over which such open space shall extend to the level of half the vertical height of the roof or to the top of the parapet, whichever may be the higher.

54. Every person who shall erect a new domestic building shall construct in the wall of each storey of such building which shall immediately front or abut on such open spaces as, in pursuance of the byelaws in that behalf, shall be provided in connexion with such building, a sufficient number of suitable windows, in such a manner and in a position that each of such windows shall afford effectual means of ventilation by direct communication with the external air.

(b.) *Actual state of things.*

Despite the elaborate provisions contained in Byelaw 53 for securing through ventilation to houses, houses are at the present time being erected at Little London, with the approval of the Local Board, *on the back-to-back plan.*

As to Byelaw 54, windows have not even been provided in the side walls of the back-to-back houses which are situated at the ends of the rows.

App. A. No. 17.

On the General Sanitary Circumstances and Administration of Rawdon; by Dr. Barry.

*Provisions with respect to the Drainage of Buildings.*

(a.) *Byelaws.*

(b.) *Actual state of things.*

61. Every person who shall erect a new building shall, in the construction of every drain of such building, other than a drain constructed in pursuance of the byelaw in that behalf for the drainage of the subsoil of the site of such building, use good sound pipes formed of glazed stoneware, or of other equally suitable material.

He shall cause every such drain to be of adequate size, and, if constructed or adapted to be used for conveying sewage, to have an internal diameter not less than *four inches*, and to be laid in a bed of good concrete, with a proper fall, and with watertight, socketed, or other suitable joints.

Byelaws 61, Clause II. The requirements with respect to the concrete bed for pipes has never been enforced. The Sanitary Authority seemingly consider disturbance of drains, through subsidence of the soil about them as inevitable, and accordingly prefer the joints to be made of clay puddle.

He shall not construct any such drain so as to pass under any building, except in any case where any other mode of construction may be impracticable, and in that case he shall cause such drain to be so laid in the ground that there shall be a distance equal at the least to the full diameter thereof between the top of such drain at its highest point and the surface of the ground under such building.

He shall also cause such drain to be laid in a direct line for the whole distance beneath such building, and to be completely embedded in and covered with good and solid concrete, at least *six inches* thick, all round.

The requirements of the 4th and 5th clauses of this byelaw have not been enforced.

He shall likewise cause adequate means of ventilation to be provided in connexion with such drain at each end of such portion thereof as is beneath such building.

He shall cause every inlet to any drain, not being an inlet provided in pursuance of the byelaw in that behalf as an opening for the ventilation of such drain, to be properly trapped.

62. Every person who shall erect a new building shall provide, within the curtilage thereof, in every main drain or other drain of such building which may directly communicate with any sewer or other means of drainage into which such drain may lawfully empty, a suitable trap at a point as distant as may be practicable from such building and as near as may be practicable

The provision of a suitable trap between the public sewer and private drain of the house has not been enforced.

to the point at which such drain may be connected with such sewer or other means of drainage.

*Provisions with respect to the Construction of Privies.*

(a.) *Byelaws.*

77. Every person who shall construct a privy in connexion with a building, and shall construct such privy for use in combination with a fixed receptacle for filth, shall construct or fix in or in connexion with such privy suitable means or apparatus for the frequent and effectual application of ashes, dust, or dry refuse to any filth which may from time to time be deposited in such receptacle.

He shall construct such receptacle so that the contents thereof may not at any time be exposed to any rainfall or the drainage of any waste water or liquid refuse from any adjoining premises.

He shall construct such receptacle of such material or materials and in such a manner as to prevent any absorption by any part of such receptacle of any filth deposited therein or any escape, by leakage or otherwise, of any part of the contents of such receptacle.

He shall construct such receptacle so that the bottom or floor thereof shall be in every part at least *three inches above* the level of the surface of the ground adjoining such receptable.

He shall not in any case construct such receptacle of a capacity exceeding *20 cubic feet.*

He shall construct the seat of such privy so that the whole of such seat, or a sufficient part thereof, may be readily removed or adjusted in such a manner as to afford adequate access to such receptacle for the purpose of removing the contents thereof, and of cleansing such receptacle, or shall otherwise provide in or in connexion with such privy adequate means of access to such receptacle for the purpose aforesaid.

(b.) *Actual state of things.*

The privies are so constructed as to effectually prevent the application of ashes, &c., to the excreta.

The receptacles, which are not cemented, are constructed with walls of porous brick, and the bottoms of flags.

The receptacles are in all cases constructed so that the bottom is from 6 to 18 inches *below* the level of the surface of the ground.

Some of the receptacles noticed had a *superficial* area alone of over 20 feet; cubic capacity ranged from 40 feet upwards.

In no case have the provisions of this clause been enforced.

As with sewerage so with regulation of new buildings; enough has been said to show how lightly the Local Board regard the responsibilities they have undertaken.

There remain to be described other sanitary circumstances of the district not yet referred to.

*Excrement and Refuse Disposal and Removal.*—Excrement and ashes (except in the case of better class houses and mansions) are univer-

sally disposed of in midden privies, many of which are of large size. All the middens are sunk a foot or more below the level of the ground and are so contrived as to prevent the admixture of ashes with the excrement. A considerable number of the middens are uncovered, and these were noticed in many cases to contain a large quantity of liquid filth. Flagrant instances were observed at Canada, Little Moor, New Road Side, and Little London. These faulty middens are in many cases situated in proximity to dwelling houses. At Nether Yeadon a privy midden, which serves for the use of the inmates of four houses, and which at the time of my inspection was full of filth, abuts directly on the wall of one of the dwellings. The scavenging of middens is left to occupiers, who are dependent upon the farmers; and, as a consequence, accumulations of filth are frequent. Midden contents are removed at intervals varying from two months to a year and upwards. Many of the middens at the time of my inspection were full to overflowing. It is interesting to note in this connexion that in 1880 the Local Board adopted a code of byelaws (allowed by the Local Government Board, February 5th, 1881) with respect to the removal of house refuse, wherein it was provided that the occupiers of premises should cleanse *once at least in every week* the privies and ashpits belonging to such premises.

The main roads are macadamized with limestone from Thornton-in-Craven, the bye roads with local stone. The main roadways are well kept, and are said to be swept at weekly intervals. None of the "private streets," I understand, have yet been "dedicated," and over these the Sanitary Authority exercise no control.

*Water Supply.*—The water supply is obtained from three sources namely: (*a*) the Yeadon Water Company (the mains of which were, first introduced into the district in 1865), whence is derived the supply to Little London, New Road Side, Little Moor, and the southern portion of the district generally; (*b*) private works constructed some 30 years ago by the late General Rawdon for the supply of houses on his estate, which houses are chiefly situated in Rawdon proper; and (*c*) a reservoir constructed by Mr. Briggs for the supply of a few houses. The water from each of these sources is stated to be of good quality, and although the Yeadon supply is said to have formerly been insufficient in quantity, arrangements have recently been made by the Company whereby their service is supplemented by an ample constant supply from the works of the Horsforth Local Board. I understand there is at the present time a considerable extension being made of the Yeadon works.

*Slaughter-houses.*—There are five slaughter-houses in the district which are stated to be inspected from time to time by the Inspector of Nuisances. They all appeared to be clean and well kept, but from some of them much of the blood and the washings find their way into the faulty sewers of the district. The Sanitary Authority possess slaughter-house byelaws based on the Model Series, which were allowed by the Board in 1881, but hitherto none of the slaughter-houses have been registered.

*Cowsheds, Dairies, and Milk Shops.*—There are a number of cowsheds in the district, but hitherto the Sanitary Authority have taken no steps to secure their registration or inspection. I understand, however, that regulations with respect to these matters have been drawn up and have been submitted to the Local Government Board, though they have not yet come into force. Some cowsheds which I inspected were apparently overcrowded, and were also very dirty.

The Medical Officer of Health (Mr. Cautley Dawson), who is in private practice in the district, receives a salary of 12*l.* per annum, no

part of which has hitherto been paid out of the Parliamentary grant. His reports, for the most part couched in general terms only, take an optimistic view of the sanitary state of the district. For example, in his report for the year 1889, he states that "the general condition of the "township is satisfactory, the various methods of sewage disposal are "on the whole efficient." He has, however, apparently made himself acquainted generally with the district, and it would seem that advice tendered by him has been frequently disregarded by his Authority.

The Inspector of Nuisances (Mr. Joseph Clark) is also the collector of the general district rate, and surveyor. He receives a salary as Inspector of Nuisances of 15*l.* per annum, as surveyor of 35*l.* per annum, and as collector of 52*l.* per annum. He appears well acquainted with the district, but does not seem to have received much support from his Authority in his efforts to secure sanitary improvement.

There are no means in the district for securing isolation of persons suffering from infectious disease, nor for the efficient disinfection of clothing and bedding. There is no system of notification of infectious disease in force in the district.

*Public Health in the District.*—In the following table will be found the mortality statistics for the Rawdon Urban Sanitary District for the nine years 1881–89, together with the numbers of new cases of sickness from certain specified diseases coming to the knowledge of the Medical Officer of Health during the same period.

TABLE showing the deaths in the RAWDON URBAN SANITARY DISTRICT, registered from certain specified Diseases, together with NEW CASES of SICKNESS therefrom coming to the Knowledge of the Medical Officer of Health during each of the Nine Years 1881–89.

| Year. | Total Deaths from all Causes. | Deaths registered from: Small-pox. | Measles. | Scarlatina. | Diphtheria and Croup. | Whooping-Cough. | "Fever." | Diarrhœa. | Rheumatic Fever. | Erysipelas. | Puerperal Fever. | New Cases of Sickness coming to the knowledge of the Medical Officer of Health: Small-pox. | Measles. | Scarlatina. | Diphtheria and Croup. | Whooping-Cough. | "Fever." | Diarrhœa. | Rheumatic Fever. | Erysipelas. | Puerperal Fever. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1881 | 28 | — | — | — | 1 | — | 1 | — | — | 1 | 1 | — | — | — | 8 | 3 | 4 | — | 6 | 1 | 1 |
| 1882 | 48 | — | 10 | — | 1 | 3 | 1 | — | — | — | — | — | 68 | 41 | 7 | 8 | 32 | — | 2 | — | — |
| 1883 | 58 | — | — | 1 | — | — | 4 | — | — | — | 1 | — | — | 13 | 1 | — | 7 | — | — | — | 1 |
| 1884 | 43 | — | 1 | — | — | — | 1 | 1 | — | — | 1 | — | 14 | 7 | — | — | 9 | 11 | 4 | 2 | 2 |
| 1885 | 59 | — | — | — | — | 1 | 1 | — | — | 1 | 2 | — | 19 | 7 | 2 | 18 | 4 | 56 | 3 | 4 | 2 |
| 1886 | 50 | — | — | — | — | — | 1 | 1 | — | — | 1 | — | 17 | — | — | — | 6 | 8 | 3 | 2 | 1 |
| 1887 | 38 | — | — | 1 | — | — | 1 | — | — | — | — | — | 5 | 7 | 2 | 2 | 2 | — | — | — | — |
| 1888 | 32 | — | — | — | — | — | 2 | — | — | — | 1 | — | — | — | — | 4 | 9 | 5 | 4 | — | 2 |
| 1889 | 45 | — | — | — | 2 | 2 | — | — | — | — | — | — | — | — | 2 | 5 | 4 | — | — | — | — |
| Total (9 years) 1881–89. | 402 | — | 11 | 2 | 4 | 6 | 12 | 2 | — | 2 | 7 | — | 123 | 75 | 22 | 40 | 77 | 80 | 22 | 9 | 9 |
| Per 1,000 living. | 12·9 | 0·0 | 3·5 | 0·6 | 1·3 | 1·9 | 3·8 | 0·6 | 0·0 | 0·6 | 2·2 | 0·0 | 39·5 | 24·1 | 7·1 | 12·8 | 24·7 | 25·7 | 7·1 | 2·9 | 2·9 |
| | | Mean Annual Mortality rates per 10,000 living. | | | | | | | | | | Mean Annual Sickness rates per 10,000 living. | | | | | | | | | |

From the table it will be seen that the mean mortality from all causes during the nine years 1881–89 has been at the rate of 12·9 per 1,000 living. From infectious diseases the chief mortality has been from measles and "fever" in nearly equal proportions. The actual number of fatal cases of "fever," which was *enteric fever*, has not been large; nevertheless the disease has persisted almost year by year, affording for the period a mean annual death-rate of 3·8 per 10,000 living, a fever rate considerably above that which obtained during the same period in England and Wales.

From the sickness table it will be observed that measles was epidemic in 1882 and in 1884–86; that scarlatina was epidemic in 1882–83; whooping-cough in 1885, and diarrhœa in 1885. It will also be noticed that multiple cases of "fever" were reported as occurring in each year of the period, and that, with the exception of measles and diarrhœa, more cases of "fever" came to the knowledge of the Medical Officer of Health than of any other infectious disease. The deaths too from puerperal fever have been considerably more abundant than was to be looked for in a semi-rural district such as Rawdon.

It will have become evident that 11 years of administration by the Local Board have been of little profit to Rawdon township. Beyond maintaining the efficiency of the main roads, all practically that the Local Board have done has been to construct one sewer for the purpose of silencing a particular complainant, and to draw up a code of byelaws which have not been enforced.

## No. 18.



On the Sanitary Condition and Administration of the Pembroke Rural Sanitary District, and upon the question of the proposed acquisition of Byelaws for the Parish of Llanstadwell ; by Mr. Spear.

The Pembroke Rural Sanitary District, occupying an area of over 56,000 acres, is situated at the south-west corner of South Wales. The broad waters of Milford Haven cut into it from the west, converting the southern portion into a promontory jutting into the sea. In the centre, on the southern shore of Milford Haven, is the Pembroke Urban Sanitary District, which includes the ancient town of Pembroke, together with Pembroke Dock; on the eastern border is the Urban District of Tenby, the noted seaside resort; and on the north is the Haverfordwest Rural District. The geological formation is the Old Red Sandstone with bands of carboniferous limestone. For the most part the district is well elevated; the site is such, in fact, as to afford great natural advantages.

Llanstadwell, with an area of 3,307 acres, and a population of 3,017, is the most important and populous parish, containing as it does Neyland (New Milford), the terminus of the Great Western Railway. This place, Neyland, is situated on the North bank of Milford Haven, immediately opposite Pembroke Dock, and besides railway employés and others engaged in the Irish passage service, a number of the workmen of the opposite docks reside in it. It is contained within the Parliamentary boundary of Pembroke, but a proposal some years ago to incorporate it within the municipal borough was rejected. At the census of 1881 the portion of Llanstadwell within the Parliamentary boundary—a portion practically conterminous with the village of Neyland—contained 392 houses and 2,183 persons. Of late years, building has been progressing here at the rate, it is estimated, of some 20 new houses annually.

The remaining 18 parishes of the district contain populations ranging from 100 to 1,000. No single village, it seems, except Neyland, contains more than 500 inhabitants, and there are only four or five in which that number is approached.

The district was visited by Dr. Airy, on behalf of the Local Government Board, and in connexion with a serious outbreak of diphtheria in the village of Jamestown, in 1880. Following upon his report recommendations were made to the Sanitary Authority by the Board as follows :—

1. The Sanitary Authority should, through their Inspectors of Nuisances, exercise more efficiently their powers under the Public Health Act for enforcing the removal of nuisances injurious to health.
2. Existing sources of water supply should be protected against surface pollution.
3. The Authority should provide apparatus for disinfection by heat.
4. The Authority should provide some means of isolation for cases of infectious disease.

In 1885, when an invasion of cholera was anticipated, the district was again inspected on behalf of the Board by Dr. Davies. On that occasion he reported that no regular means of drainage existed; that roadside gullies served as slop-water drains ; that privy-pits or cesspools, often dangerously near sources of water supply, were in general use,

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On the Sanitary Condition and Administration of the Pembroke R.S.D.; by Mr. Spear.

and that many houses possessed no privy accommodation; that no public arrangements for scavenging existed; that water was chiefly derived from wells requiring protection from pollution, and that the cottages of the poor were often damp and ill-ventilated. He further reported that in dealing with these and other conditions injurious to health the Sanitary Authority showed little activity.

The Sanitary Authority delegate their powers to a Sanitary Committee, composed now of 20 members. In ordinary course this committee meets at quarterly intervals only, but special meetings are occasionally held, so that during the last two years and a half there has been an average of six meetings annually. The Medical Officer of Health and the Inspector of Nuisances report on these occasions, and from the reports of recent years I find the following matters have been brought prominently under the notice of the Authority :—

*As to Llanstadwell.*—In his report for the year 1886 the Medical Officer of Health speaks of the prevalence of cesspit, privy, and other filth nuisances at Neyland; owing partly to structural defects in much of the house property, and partly to the fact that the inhabitants "have "no means of carting away their refuse, but are entirely in the hands "of one or two carters who only come when it suits them." "The "way between Connor's Row and Cambrian Terrace cannot be called a "road," he says, "it is simply a mass of filth. . . . The back of "Connor's Row is equally dirty, with privies, cesspools, &c., in a very "limited space, so that the smell is terrible." . . . "Cambrian "Terrace, opposite Connor's Row, is very little better." In the report of the following year Connor's Row is spoken of as "perhaps slightly improved;" nuisances are referred to as arising from accumulations of "filth, ashes, and blood," behind Picton Place, and from overflowing cesspits behind Riga Place, "so that the stench is well-nigh intolerable;" the High Street is spoken of as "in much the same condition as "for some years past. Still to be seen heaps of refuse . . . Slops "thrown into the road. Many of the people complaining of the want "of a public scavenger."

In August 1888 a serious outbreak of scarlet fever in Llanstadwell is reported; "up to the 15th of August 12 children died of the fever or its results," the Medical Officer of Health says; and the sanitary deficiencies of the parish are again enumerated: Connor's Row is in a "lamentable condition;" the streamlet at Great Honeyborough is converted into a series of cesspools; many houses are filthy (one in which three deaths occurred is spoken of as a "miserable ill-ventilated dwelling"); bad cesspools are common, and those at Connor's Row are within a few feet of the back-doors; the slaughter-houses are so constructed and so managed as to create nuisance. Again, in the report for 1889, Llanstadwell is referred to in terms which show that the same conditions prevail; and in addition, the water supply is complained of.

*As to other villages in the district.*—In his report for 1886 the Medical Officer of Health say, "Scavenging in all the villages is very "imperfectly done, heaps of manure being put together to remain near "houses decomposing, or to be washed abroad in times of rain," and Castle Martin, Jamestown, and Nash are specially referred to in this connexion. In the report for 1887, "Saint Florence and Nash are not "scavenged as they should be, there are always heaps of decomposing "matter about these villages." In the report for 1889, "The village "of Jamestown is always dirty."

In September 1889 a fatal outbreak of diphtheria was reported from Angle. Amongst a population of some 500, six deaths from this cause

were recorded, three in September and three in November. Reporting upon the occurrence, the Medical Officer of Health says that an open drain in the bed of a small stream runs the length of the village street, or is converted in dry weather into a series of cesspools; that filthy cesspools are close to the houses, and that privy and pigstye nuisances prevail; and in January 1890, when a house-to-house inspection of the village was ordered, the Inspector of Nuisances further reported—"25 pigstyes or privies adjoining dwelling-houses; 12 drains choked; "6 cesspits choked." In his report for 1889 the Medical Officer of Health notes that he had reported the condition of the drainage of this village to the Authority "some years ago."

I have searched the minute book of the Authority to ascertain the action ordered by them upon these reports, and have visited the most populous villages in the district to learn by personal observation the actual conditions prevailing.

*Action of the Sanitary Authority.*

*As to Llanstadwell.*—Two dip-wells at Great Honeyborough (upper part of the parish) have been protected against surface pollution, and the bed of the streamlet there had been cleared of obstruction, but has now again become foul; the Inspector of Nuisances has received orders to prosecute anyone throwing sewage or refuse on the roadway at Connor's Row; the keeper of a slaughter-house was proceeded against for a recurring nuisance.

Neyland, which forms the principal portion of this parish, stands on the slope and summit of a hill overlooking Milford Haven. It consists of one long main street and several cross streets, and, as I have already stated, building has lately been progressing briskly. No sewers have been provided, and sewage is discharged into any convenient gutter, or is thrown on to the open spaces about the dwellings, so that practically nuisance from this cause is universal. Deep privy middens or cesspits are in general use, and there are many instances of very close proximity of these structures to the dwellings. There is no public provision for the removal of refuse, and the people have evidently great difficulty at times in securing its removal. When undertaken by a farmer or carter the work, moreover, is not done gratuitously, and the careless tenants will allow large accumulations to take place, rather than defray the cost. The charge, again, not being fixed by any rule, is variable; and, still worse, even when undertaken, the work is often negligently and imperfectly done. I saw one midden that was supposed to have been just recently emptied that still contained a considerable accumulation of foul matter, and this, I am told, is a common experience. At Connor's Row the people have to carry the contents of their privy-pits and ash-pits, from tiny and enclosed backyards, through the house passage to the street, and it is then generally deposited before removal on the unpaved road. Heaps of ash-pit and other refuse, deposited apparently after removal from the ash-pits, were met with in other parts of the village (behind Cambrian Terrace, for example, where a narrow passage was partially blocked up with such matter, behind Riga Place, and elsewhere). The presence of three ill-kept slaughter-houses, and the unregulated keeping of pigs, add materially to the general prevalence of filth nuisances in this village.

There is a great need for a proper water supply at Neyland. The inhabitants of the upper part of the village resort for the most part to the springs already referred to at Great Honeyborough, a distance for the nearest of nearly a quarter of a mile. At the lower part of the village water that the railway company have provided for their premises, and

to which they allow public access, is mainly relied upon. Like the others, however, this source (the tap being situated at the foot of a steep bank) is not reasonably accessible; and, moreover, it is liable to dangerous contamination. I traced the brook from which the reservoir is supplied, and its tiny tributaries, upwards some distance, and found the washings from cottages, from pigstyes, and from farmyards, draining into them; and at one point, about a mile above the reservoir, I found the banks of the main streamlet being made use of as a common privy and place of deposit for all sorts of refuse by the occupants of an adjacent cottage.

There are a few local wells in the village, but they are apt to fail in dry summers, and, sunk as they are in a soil much polluted, they cannot be regarded as affording a safe or wholesome water. For houses recently built large underground tanks have been made for the storage of rain water; and this mode of supply, unsatisfactory as it is, is perhaps the best that the village at present affords.

*As to the remaining part of the sanitary district.*—During the last two and a half years I find that in some half-dozen cases a little work for the protection of a local well or spring has been undertaken; that in a few cases owners or occupiers of property have had notice to abate privy, drain, or pigstye nuisances; that in one case a house unfit for habitation was dealt with; in two overcrowding was abated, and in two the owners of slaughter-houses were proceeded against.

At Angle, the foul open sewer along the village street remained at the time of my visit in the condition described by the Medical Officer of Health in his report on the diphtheria outbreak. It is a dilapidated and uneven gutter, with no paving and little fall, and such of the sewage as finds its way to its termination is received into a pond adjoining the village National School, and just opposite the school-doors. The greater part of the slop-water of the village finds its way into the gutter; cesspit-privies overflow into it, and at various points soakage from pigstyes is seen percolating in its direction.

At Jamestown, after Dr. Airy's inquiry into the outbreak of diphtheria there, the Authority supplied a pump to, and covered over, the dip-well. The covering, however, is imperfect, and contains gaping crevices, while filth of all sorts, at the time of my visit, lay immediately around. The pump (which affords the only drinking water, except that supplied by rain butts, for a radius of half-a-mile) has for some time, too, been out of repair. In this village there is no drainage; and sewage, privy, and pigstye nuisances meet one at every turn. A few of the cottages have no privy accommodation of any sort; some are damp, close, dilapidated, and altogether unfit for human habitation. The Manorbier schools, which accommodate this and neighbouring villages, have cesspit privies about 12 feet from the school-doors.

In its general state of filthiness, and in the conspicuous absence of any proper attention to the removal of refuse matters from the streets and about the houses, the village of Jamestown finds its counterpart in the village of St. Florence. Here also there are houses unfit for human habitation, and others overcrowded.

At Penally, near Tenby, I found houses of comparatively modern date, and supplied with waterclosets, draining by unventilated drains into unventilated cesspools. At Manorbier also a little building of this kind has been permitted.

There has been no serious attempt to regulate dairies, cowsheds, and milkshops in the district, although some few have been registered. It is evident that their regulation, and often improvement in their

structural condition—in their paving and drainage, for example—are much required.

No means have been provided for the isolation of cases of infectious disease.

Mortality returns of this district have not been forwarded to the Board in due course, and I have hitherto failed to obtain them in their entirety from the Medical Officer of Health.

*The provision of byelaws for the parish of Llanstadwell.*—This question has for a long time past engaged attention. In April 1886 the Authority were invested with urban powers under sections 42 and 44 (so much as not already in force), and under sections 157 and 158 of the Public Health Act. In January 1887 the Authority proposed to adopt byelaws with respect to:—

1° Removal of refuse, cleansing of closets, &c.
2° The prevention of nuisances, &c., and
3° New streets and buildings;

for the whole parish. On September 10th, 1888, they proposed to limit the operation of these byelaws to a certain portion of the parish; on the 18th of the month they proposed that the limit should be somewhat extended; on the 10th of October they desired to return to the smaller area; on the 31st of December it is again proposed that the area should be what may be termed the medium-sized one, represented by the Parliamentary boundary; on the 20th of September 1889 it is decided that the whole parish shall be included; on the 12th of May 1890 they propose to abandon the application of the byelaws entirely. The initial question, as to the area to which the proposed byelaws shall apply, has thus taken four years to discuss, has been the subject of seven contradictory resolutions—the final determination being to do nothing. Meanwhile, houses, the building of which, had the Authority possessed these byelaws, would be subject to proper regulations, are being put up with no sufficient regard to sanitary requirements. No special preparation of the foundations in the manner contemplated by the model byelaws is attempted; there is often no proper provision for damp-proof courses in the walls, nor sufficient provision for ventilation under the floors. Drains are left unventilated, although they are often carried beneath the house; they are not, as they should be in such a position, embedded in concrete; and they have no proper place for discharge. Rooms without fireplaces are unprovided with special means of ventilation. Privy-pits are constructed on the old-fashioned objectionable plan. In one case, at least, a new house has been built in the yard space of an old one so as to leave neither with any proper open area.

So far as byelaws with respect to removal of house-refuse, and the cleansing of privies, &c., are concerned, I have already said sufficient to show that Neyland is not a place where, on the whole, this duty can properly be left to the occupiers of premises. The Authority should themselves make the necessary provision under section 42 of the Public Health Act.

Byelaws with respect to nuisances, on the other hand, are desirable for the regulation of the removal, in individual cases, of refuse, where the latter is required by the owner for manure, or where, as in Connor's Row, public ashpits might advantageously be brought into use. The regulation of pig-keeping also, and of the lairage of cattle, is much needed in Neyland, and might be effected under this series (2°) of byelaws.

Byelaws for the regulation of buildings should, as I have said, be applied to Neyland, and to any other place where building operations

are probable, without delay. At present the builders of the district have no proper conception of what, in the interests of the public health, is needed of them.

Referring again to the general sanitary administration of the district, I found that there was little co-operation between the Medical Officer of Health and Inspector of Nuisances. The systematic inspections (apart from inquiries into particular outbreaks of disease), to which the Board attach so great importance, are rarely made by the Medical Officer of Health, and never by the two officers acting in unison. The records of the Authority to which I have referred show that the general reports of the Medical Officer of Health have not received the attention required, but it is evident also that the conditions prevailing have not been brought in sufficient detail, nor the necessities with sufficient frequency and insistence, before the Authority. It is evident, in fact, that the Authority meet at too infrequent intervals to adequately superintend and direct the administration of so wide and necessitous a district. Careful systematic inspections should be made by the Medical Officer of Health and Inspector of Nuisances acting together; the results should be laid in detail before the Authority at monthly intervals, and proper records of the decisions of the Authority on matters so reported, and of the results of the action determined upon, should be preserved.

I met the Authority after my inspection of the district and related to them in some detail the conclusions I had formed as to its condition and sanitary requirements.

No. 19.



Introduction to Dr. Parsons's Report on the Influenza Epidemic of 1889–90; addressed by the Medical Officer to the President of the Local Government Board. (May 1891.)

Introduction to Dr. Parsons's Report on the Influenza Epidemic of 1889–90; by the Medical Officer.

Sir,

I have to present a report by Dr. Parsons, of the Medical Department, upon the prevalence of Epidemic Influenza in England and Wales during the years 1889–90. It forms a worthy addition to the excellent monographs on Influenza that have been contributed to English medical literature.

Dr. Parsons's Report on Influenza.

Dr. Parsons does not strictly confine his report to the epidemic of our own country, but he tells us what he has been able to learn of the epidemic elsewhere. In thus treating of the history and geography of recent Influenza, his report may be compared with the records of earlier epidemics. But Dr. Parsons has been able, probably on better evidence than any previously adduced, to deal with the problems offered by the different behaviour of the malady in one and another locality of England and Wales. He has derived his abundant and detailed materials from a great number of medical practitioners, among whom Medical Officers of Health are naturally foremost.

Origin of the disease.

The matter which exercised the public mind throughout last year was the Source of Influenza. As to this, I fear that, to many people, the report will be disappointing. The universal desire in every country appears to have been to accuse another country of generating the epidemic; accusing by preference the more distant ones. Russia, among European countries, has been held to have originated the disease, it would seem on no better ground than the early date of its prevalence in Russia. China, among still more distant countries, has had the credit of being the birthplace of Influenza; it would seem because some great Chinese rivers overflowed their banks in 1888 and 1889.

Manner of extension.

But what appears much more important than the origin of the epidemic, is the evidence that Dr. Parsons has gathered, tending to a better knowledge of the manner of extension of Influenza. The disease has long been regarded as of the "miasmatic" group; of that group, namely, wherein pathologists and statisticians comprise the common infectious diseases of our own and other countries. But probably no evidence has ever been put on record, in such abundance as that accumulated in Dr. Parsons's report, to show that in its epidemic form Influenza is an eminently infectious complaint, communicable in the ordinary personal relations of individuals one with another. It appears to me that there can henceforth be no doubt about the fact.

In some circumstances it would seem that infectiveness of Influenza through the atmosphere shows itself over a wider area than the limits of household life. Probably also there are other less direct ways by which the infection of the disease can travel; and ways, moreover, by which the infection can be retained for a time in a state of suspended

activity. These characters observed in the extension of epidemic Influenza would appear to be little else than we are familiar with in the behaviour of other diseases of the infective class. But we have no doubt much to learn about the dissemination of Influenza; and particularly of the stage when the complaint acquires its epidemic power.

Specialities of Influenza extension.

By having established a place for this Influenza among infectious diseases, we assert a position for the disorder within a class of diseases over which we habitually exercise a measure of control. But from what we have thus far seen of the specialities of Influenza, we cannot feel particularly confident of our ability, under the existing conditions of society, to successfully defend ourselves against a further outbreak. A disease that can be absent in an epidemic form for 30 years together cannot, even if a first attack confer immunity, avail to give the protection of a first attack to any large part of a population. Early isolation precaution, applicable perhaps to children suspected to have measles, cannot well be applied to persons suspected of Influenza among the bread-winners of a community; and the singular ability possessed by Influenza to disperse itself over a population, owing to its brief incubation period, must add to the difficulties of dealing with an infection that finds the bulk of the population susceptible to its attack. Having, as would seem, something like a third part of the incubation time proper to small-pox, measles, or typhus, Influenza has correspondingly rapid ability to reproduce itself; can, that is, give rise to some thousand attacks in the time that small-pox or typhus had taken to produce ten; each of the thousand cases being ready to infect other susceptible people, and the difficulty of applying principles of isolation and disinfection being in like measure enormously enhanced.

Need for further information.

For better means of repressing Influenza our expectation must be in an understanding of the natural history of the disease. Even for immediate purposes, it would be no small gain to get more authentic methods of identifying Influenza proper from among the various grippes, catarrhs, colds, and the like—in man, horse, and other animal—that take to themselves the same popular title: so we might get earlier opportunity for applying such preventive measures as we now possess, instead of delaying our procedures until obscure cases have multiplied and the disease prevails in its more definite form: until the time, namely, of major abundance with perhaps a faculty of readier dissemination. For the rest, better understanding of the natural history of Influenza has to be obtained—with insight into the characters, habits, and conditions of multiplication of its material,—with a view to acquiring by other methods further and better safeguards against the disease.

## No. 20.

## Report on Slop-Closets and Trough-Closets; by Dr. Parsons.

On Slop-Closets and Trough Closets; by Dr. Parsons.

Occasion of inquiry.

The occasion of this inquiry was an application to the Local Government Board by the Ilkley Urban Sanitary Authority for sanction to a byelaw requiring that where alterations were made to existing privy accommodation, or where new closets were erected, the closet known as the "waste-water automatic closet," should be fixed, unless the levels rendered this system impracticable, in which case the ordinary cistern watercloset should be fixed. The Board had also the prospect of byelaws being submitted for their sanction under section 23 (1) of the Public Health Acts Amendment Act, 1890, which, when adopted in any district, empowers the local authority to make byelaws, *inter alia*, with respect to "the keeping waterclosets supplied with sufficient water for flushing."

In view of these circumstances I was instructed to undertake a general inquiry into the subject of automatic waste-water closets, and automatic flushing trough-closets, their advantages and drawbacks, and the circumstances and conditions under which they might properly be used, with reference to the preparation of a model byelaw suitable for their regulation. After conferring with Dr. Barry, who had already collected some information on the subject, I visited the following places where closets of one or other of these kinds were in operation, viz., Ilkley, Leeds, Bradford, Bingley, Burnley, Huddersfield, York, Newcastle-on-Tyne, Walker, Swinton, Barnsley, Blackburn, Birmingham, Hanley, Liverpool, and Bristol, and I here beg to acknowledge the courteous assistance which I have received from the local authorities and officials at those places.

### I.—Slop-Closets.*

Slop-Closets.

By a "slop-closet," I mean a closet from which the excrement is intended to be washed away into the drain by means of the slops or refuse liquids of the household, instead of by clean water supplied for that purpose; and by an "automatic slop-closet," I mean one in which, with a view to giving a better flush, the waste liquid, instead of escaping directly into the closet, is held up and discharged from time to time in a sudden forcible stream.

Hand-flushed hopper closets.

The utilization of the refuse liquids of the house for removing the contents of the closet is no new idea. Occasionally in my various former inspections I had found instances in which the slop-stone pipe was led

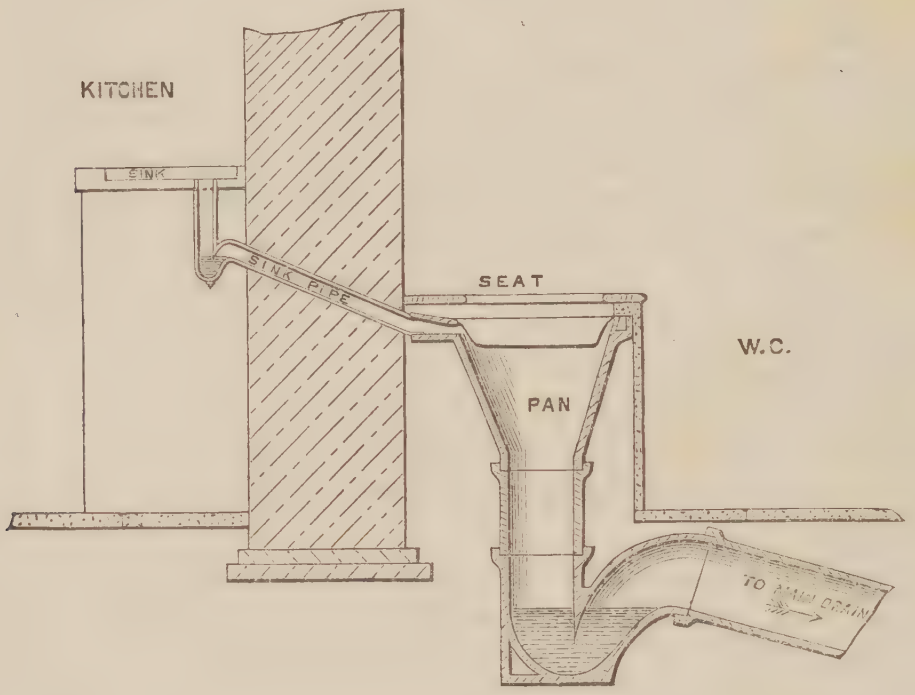
* I prefer the term "slop" to "waste-water" closets, as being shorter, and more free from ambiguity.

App. A. No. 20.

On Slop-Closets and Trough-Closets; by Dr. Parsons.

direct into the closet-pan with the intention that the contents of the latter might be washed out by the liquid poured down the sink, or by clean water from the tap over it, as in the diagram, Fig. 1. More

Fig. 1.




often, however, the closet-pan is unprovided with any such connexion, and is intended to be flushed by throwing down water by hand; the dirty water of the household being used for this purpose, supplemented if necessary by clean water. (Such a closet is sometimes called a "cottage pan.") All such closets are intended only for out-of-door use.

The objection to either of these arrangements is that the force and volume of the water which under such circumstances goes down the closet is insufficient to keep the pan clean, or to remove the excrement effectually from the trap (especially where water has to be fetched from a distance, or where the liquid refuse can be disposed of by other and easier channels), and consequently in such closets the pan is commonly found smeared with filth, and stoppages in the drain are of frequent occurrence.

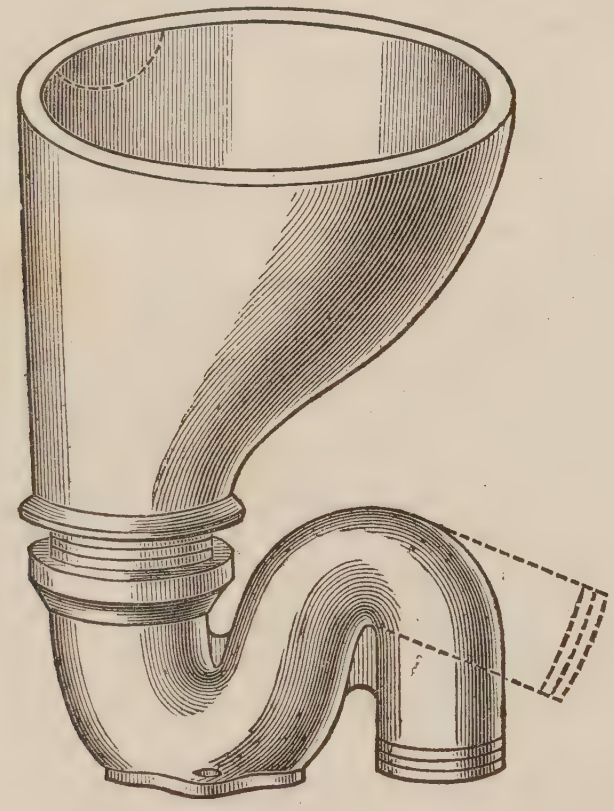
Bristol eject closet.

A form of closet intended to overcome this difficulty and avoid the frequent stoppages to which the ordinary hopper-closet without water is liable, was described and figured by the late Mr. Netten Radcliffe in his report "On certain means of preventing excrement nuisances in towns and villages," 1874, under the name of the "Bristol eject." This consisted of a shaft or "trunk" of brickwork faced with cement, communicating through a deep and capacious freestone trap or "eject" with a 9-inch drain. The advantages claimed for this form of privy were its little liability to get out of order through careless use or violence, and the facility with which foreign matters thrown into it could be removed. Its satisfactory working, however, according to

Mr. Radcliffe, required a plentiful and readily accessible supply of water for flushing (clean water being used for this purpose, in addition to the slop water), and frequent inspection and systematic cleansing by the public authority.

Dr. D. S. Davies, the present medical officer of health for Bristol, states that the closets with brick trunk and freestone dip-trap as described by Mr. Netten Radcliffe have not proved a success, and are now discountenanced by the Health Department of that city. The cement facing soon scales off, leaving porous brick with irregular joints, and this gets coated with excrement and horribly foul. The old freestone trap or "eject" had a very short life, and was in consequence replaced by an earthenware dip-trap, but in place of the whole structure the Health Department now recommend a glazed pan, with straight back and 6-inch trap; in shape and working like a double-sized cottage pan and trap, Fig. 2. (The pan as

Fig. 2.



now used has exactly the shape of the bowl of a clay tobacco pipe, being narrower in proportion to its height than in the figure.) The larger outlet is used because the outdoor artizan closets are dependent on bucket-flushing by hand, and a 4-inch trap would speedily choke.* These non-absorbent glazed pans, according to Dr. Davies, are a great improvement on the brick trunk and eject: they last well, being strongly made ($\frac{5}{8}$—$\frac{3}{4}$ inch thick) in order to stand rough usage, and they are

* The dotted lines show an alternative direction of the outlet to suit a shallower drain.

cheap, costing with trap 5*s.* 6*d.* in brown ware, or 6*s.* 6*d.* white-glazed inside. In some cases the rainwater pipe is led into the pan, a semi-circular notch being made at its upper border for its reception, and occasionally the waste water from the yard gully is led into the closet above the trap as in the form next to be described. As there is difficulty at Bristol in getting water laid on, the water-supply being in the hands of a company, whose minimum charge for the supply of water to closets is 10*s.* per annum, these closets are considered by Dr. Davies fairly satisfactory for their object. The earthenware pans, however, tend to get dirty if neglected, where water is not laid on, and the system of supervision and cleansing of closets by labourers under the inspectors of nuisances is still continued in the poorer districts of the city, and is found to be very necessary for the keeping clean of bucket-flushed closets.

At my visit to Bristol the closets with brick trunks which I saw were found almost without exception in the state described above by Dr. Davies, and extremely offensive, even when visited daily and sprinkled with carbolic powder by the servants of the Corporation. Some of them were choked and full of excrement up to the level of the seat; and in the case of one which was undergoing reconstruction, the earth around the trunk and "eject" (which latter has to be connected with the drain by a "mason's joint") could be seen to be saturated with excremental matter which had leaked therefrom.

The closets with earthenware pans were found in good order and clean, where the closet belonged to a single house occupied by cleanly people; but those in common courts were often dirty, the pans being smeared with dried-on excrement. This was especially the case with those accessible to passers-by in the street, and those in dark, confined situations; of these the whole closet—pan, seat, and floor—was in a disgustingly filthy condition. It appears to be the custom to throw the chamber slops into the closet, but the washing water is more generally poured down the yard gully, an occasional bucketful of clean water being drawn to flush the closet. An objection to pouring the waste water down the closet is the splashing of the seat which is apt to take place.

Fowler's, or Southport closet.

A first step of improvement upon hand-flushing was to carry the slop water by a drain from the yard gully into the bottom of the shaft of a closet similar to the Bristol one. A closet thus arranged, but with a shaft constructed of earthenware or sheet iron, and called after its inventor, "Fowler's closet," is largely in use in Newcastle-on-Tyne, Salford, and Hanley, and I have occasionally seen examples in other places. *See* Fig. 3 opposite.

Experience at Southport;

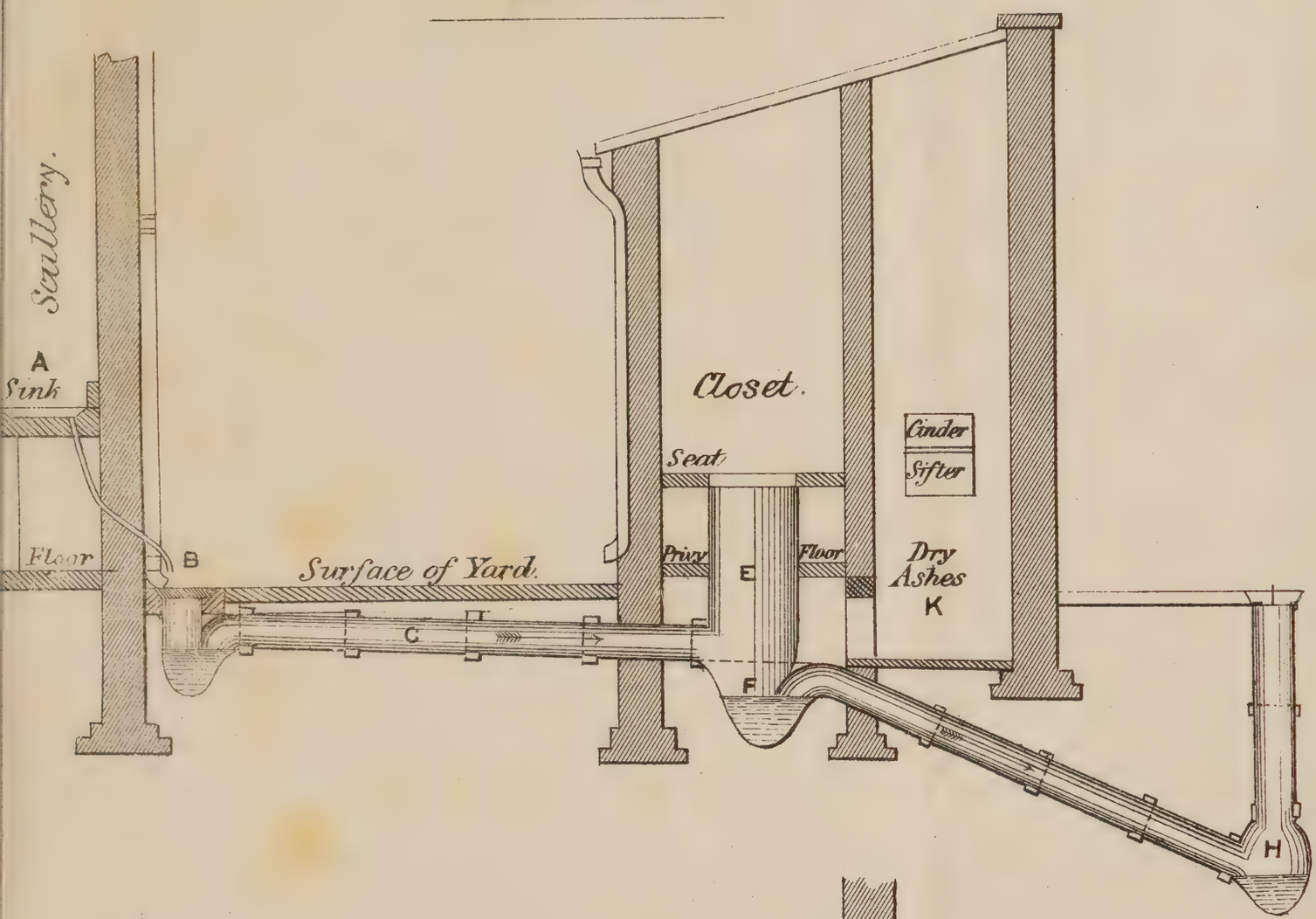
A similar closet, but called there the "Bristol eject" (though different from the closet in use at Bristol), was observed by me in 1886 in use at Southport, where it appeared to act satisfactorily under the conditions which there obtained, of frequent supervision and flushing of the drains by men in the employ of the Corporation.

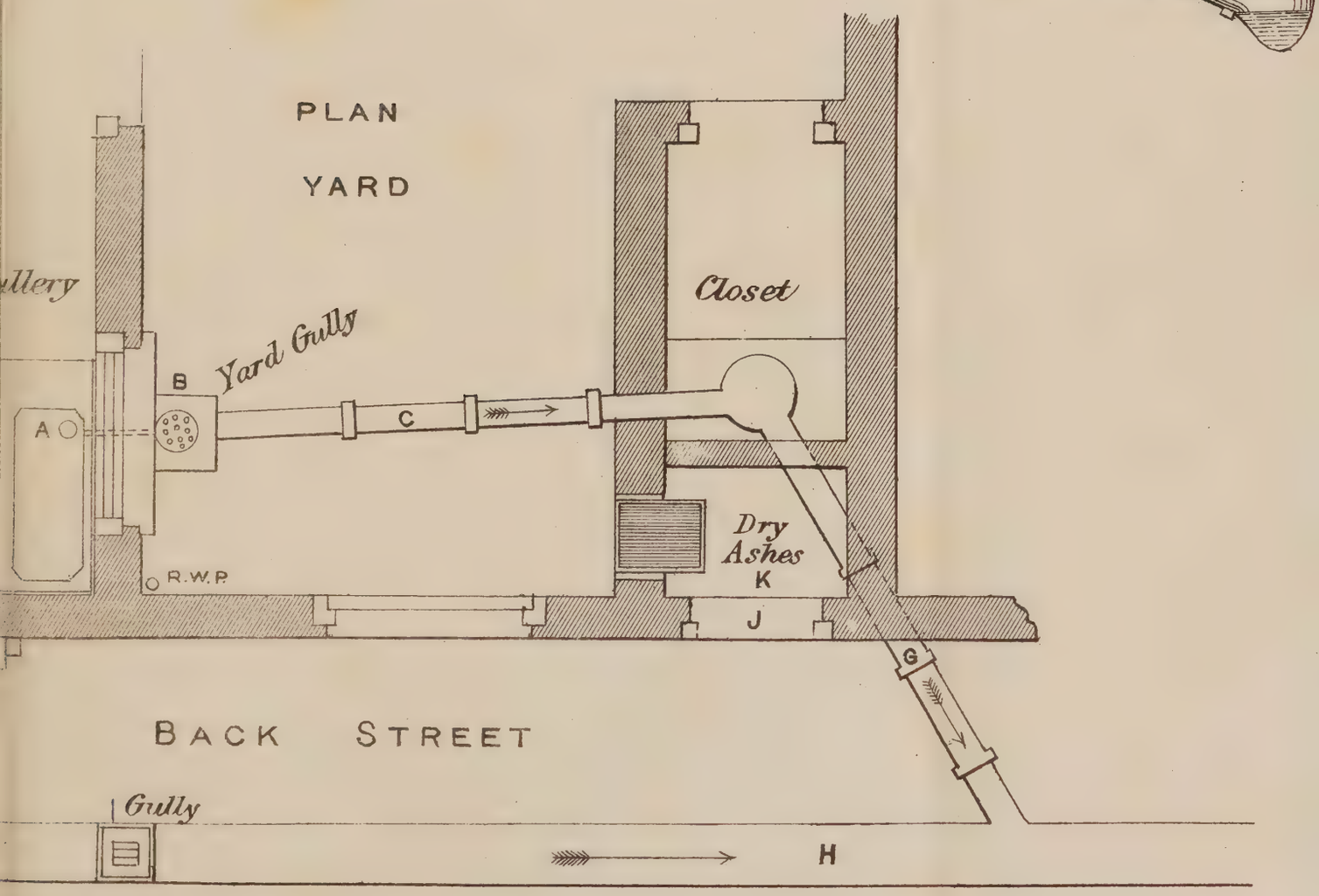
FIG. 3.

*To face p. 162.*

# FOWLER'S PATENT CLOSET.

## SECTION.

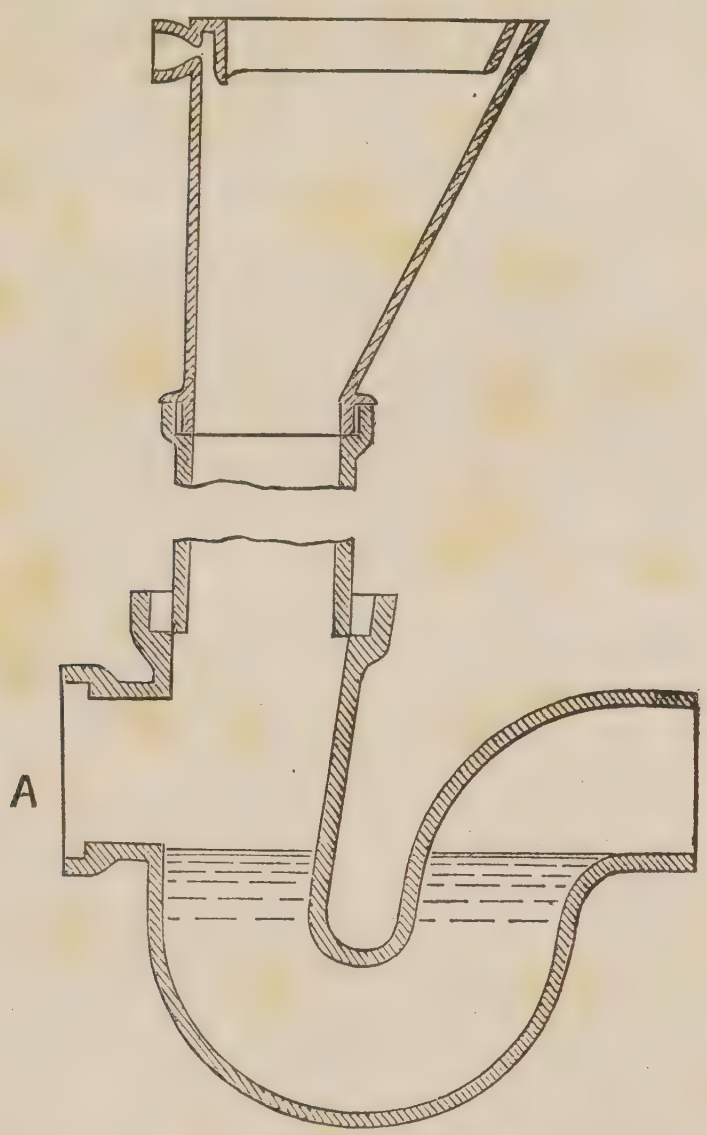



Judd & Co Lith. 73 & 75, Farringdon Rd & Doctors' Commons.

Dr. Vernon, medical officer of health for Southport, to whom I am indebted for the accompanying figure, No. 4 :—

Fig. 4.




states that in March 1878 a deputation from Southport, of which he was a member, visited a number of towns, Bristol amongst them, and came to the conclusion that the Bristol arrangement, with some modification, was the best form of closet they saw.

The first modification made at Southport was to introduce waste-water by the inlet marked A on the sketch, and then the brick-built trunk was abandoned and the whole was made of very stout brown earthenware. The Southport closet was thus evolved from the Bristol one, but the Southport people did not think it so different as to need another name, that of "Bristol eject" having become familiar.

Dr. Vernon states that the first account which he saw of Fowler's closet was in the "Sanitary Record" of 15th February 1880, by which time hundreds of the new closets had been erected in Southport.

It is the practice at Southport to lead all the waste water from the premises, from slop-stones, baths, cistern overflows, and sometimes roof water, through the trap of the closet; the waste water being first delivered in the open air over a trapped gully. The closets are not visited in the frequent systematic manner adopted at Bristol, but two men go round and flush the drains of every house about once in six

weeks, pouring at the same time several bucketfuls of water down the closet pan, so as to sweep all deposit forward into the sewer. (The drains at Southport have rather flat gradients, owing to the nature of the site, and they are also apt to be choked by blown sand.) Householders are instructed not to rely upon the water running through the ejects, but daily to pour buckets of waste water or suds down the pan, so that the frequent minor flow may be supplemented by an occasional good flush. In houses where there is a bath, frequently used, no auxiliary flushing is necessary. No "tipper" or siphon tank is used. On the whole, the system is locally considered to work fairly well, and the flushing to be sufficient; in the houses of the lowest class, however, sufficient water is not used, and the basins get dirty.

"In the case of all classes," says Dr. Vernon, "we find improper things put down the Bristol closets, but this is equally true of all outside closets, whatever the pattern. Sardine tins, preserved meat cans, sticks, brushes of all sorts, cats, broken brickbats, rags, dusters, brown paper, knives, spoons, forks, and a host of other small things, are found either lodged in the dip trap, or incarcerated at some point between that and the junction with the street sewer, generally at a Y junction. These obstacles act like weirs and dam up sewage behind them, but in the absence of such obstructions, I am bound to say that where the gradients of the private drains are what they ought to be, the drains where there are Bristol ejects are not more frequently stopped up than drains where there are no Bristol ejects. Nuisances will of course occur under any system, but the Bristol eject is such an enormous advance upon the midden privy, and so infinitely superior to any earth or pail system, that I should be sorry to see any change here."

at Newcastle-on-Tyne;

At Newcastle-on-Tyne Fowler's closets were not liked either by the sanitary officials or by the tenants; the objections raised to them being the following:—

1. The force of the stream of water is insufficient to effectually remove the excrement. I myself observed in many instances a lodgment of excrement at the bottom of the closet, and I was told that it was the custom of some persons to leave the watertap over the sink running in order to flush the closet.
2. The shaft is apt to be fouled, especially at the back, by excrement falling against it. Owing to this and the preceding cause, the Fowler's closets seen by me at Newcastle had almost always an offensive smell.
3. The closet is apt to be blocked by improper substances being thrown down it.
4. Several mothers expressed a fear of children falling down the shaft whilst using the closet, in which case their extrication would be difficult. I did not however hear that this accident had ever actually happened; and it might be prevented by making the hole in the seat smaller.

At Walker, where the adoption of Fowler's closets was recommended by the Building and Sanitary Committee of the Local Board in April 1882 (in a report from which the accompanying illustrations (Fig. 3) are taken), I found that only four closets of this kind had been fixed, and that two of these had subsequently been converted into pail-closets.

at Hanley.

At Hanley, on the other hand, Fowler's closets and another very similar pattern, Marks's, have been largely used since about 1884, for new houses and in substitution for old "cesspools" and pail privies.

The present number of closets of different kinds in Hanley is estimated by Mr. Lobley, borough engineer, as follows:—

2,000 "cottage basins," *i.e.* earthenware short hopper with siphon trap, hand-flushed.

700 slop waterclosets, Fowler's and Marks's.

500 indoor waterclosets.

3,000 pail closets.

4,000 old style privies and "cesspools."

What is called a "cesspool" at Hanley is merely the space under the privy seat, which is dug out to a depth of two or three feet below the surface. The pit so formed is lined with brick or stone and cemented. It contains about a cubic yard, and is emptied perhaps two or three times a year, according to circumstances. It contains excreta only: the ashes being placed in separate ashpits. The emptying has been undertaken by the Corporation for the last 15 years, before which it was carried out by farmers at the occupiers' cost. This system is objected to by the Corporation on sanitary grounds, viz., on account of the nuisance arising from the retention of the excrement in populous localities; the liability to pollution of the loose soil (made ground) on which much of the town is built, and the offensiveness of the emptying, especially where the contents have to be carried through the houses; and many of the old privies have been reconstructed.

In 1873 the pail system was adopted by the Corporation. The manure, for which there was more demand then than there is now, was sold in a crude state to farmers. The pail system, however, is now disapproved partly on sanitary grounds, and partly on account of the great expense involved in carrying it out properly; and the number of pails is being rapidly reduced.

At first the pails were removed in the daytime in a van to the depôt for emptying and cleansing; a clean pail being substituted for that removed: but the expense of this system was found too great, and in consequence the cleansing was abandoned, the pails being simply emptied into a cart, sprinkled with disinfecting powder, and replaced. The offensiveness of this operation led to a return to night collection.

Another modification tried was to require the pails to be furnished with a perforated partition, to allow the liquid which found its way into the pails to be drained off into the sewers through a small earthenware gully underneath. This experiment utterly failed. The perforated partition soon became clogged up, and ceased to pass the liquid through: and the stagnant putrid liquid in the gully became most offensive. The advantage to the drains and sewers of keeping out the solid excreta and paper was nil, for the stale liquid mixing with the silt in the sewage, in the absence of any extra flushing water, was far more obnoxious than if the entire excreta had been passed fresh into the sewers. At its best the partitioned-pail system barely reduced the cost of collection by one half, and it has now been abandoned. Out of 3,000 pails estimated to be in the borough, not 100 have partitions, and these are abolished as fast as found out; the pail and gulley being removed, and a cottage basin fitted to the drain.

The cost of the pail system, as now carried out in Hanley for labour and cartage, is estimated at 650*l.* per annum for 3,000 pails. This is equal to 1*d.* per week, or 4*s.* 4*d.* yearly per pail, and about 10*d.* per annum per person using them. But as a penny rate in Hanley produces 650*l.*, a house rated at 7*l.* pays only 7*d.* for this work, so that the remaining 3*s.* 9*d.* has to be paid by higher-rated premises, not requiring the duty to be performed at all.

Fowler's system was introduced about 1883 and is now used for out-of-door closets wherever practicable; but a fall of at least five feet to the sewer is necessary, and there are many places in which it cannot be

used on account of the want of fall, the ground sloping upwards from the back of the house. In such cases "cottage basins" are used; viz., closets with a short hopper and siphon trap; which are flushed by pouring down water, dirty or clean, by hand.

There are few common courts in Hanley; the houses having usually separate yards and closets.

The water supply is in the hands of a company, who have not hitherto made any extra charge where slop-closets are in use, though I was informed that they claimed the right to do so; the average daily supply is 20 gallons per head. Hanley is sewered; the sewage is treated by the lime process, and intermittent filtration of the effluent through land; this treatment costing in working expenses 1,300*l.* a year, or about 5½*d.* per head of the population. Of the two forms of closet, viz., Fowler's and the "cottage basin," the borough engineer is unable to give a preference to one or the other; but would prefer a slop-closet with an automatic flushing arrangement to either. In both Fowler's closets and the cottage basin the pan is often found smeared with filth, but this depends very much upon the habits of the persons who use it; neither would keep in order at houses of the lower class without attention. The Corporation employ two men for the purpose of going round to look after the closets and "educate the people in their use," the most efficient instrument in this education being found to be a charge made for unstopping the closet when it becomes blocked. The first stoppage is cleared without charge; but for clearing a second stoppage a charge of 1*s.* is made; and for any subsequent one a charge of 2*s.* The stoppages requiring to be cleared are on an average about two per week for the whole of the closets of both sorts in the borough.

Of 21 Fowler's closets seen by me in a walk through Hanley 19 were fairly clean and free from offensiveness (though there was generally some soiling of the shaft), and in two there was a moderate accumulation at the bottom; one of the latter, however, belonged to an empty house, but was used by passers-by in the street; there would therefore be no water passing through the closet to wash away the excrement deposited in it.

The "cottage basins" seen were less satisfactory; out of eight seen, the pans of five were smeared with filth, and only three were clean. One of the five was stopped up, and in another there was an escape of sewer air from a defective joint. The cottage basins were said to have been frozen up during the late severe frost, and had to be unstopped by pouring down hot water. Both forms of closet were greatly superior to the old "cesspools," of which the examples that I saw were very offensive.

Dr. Hill's closet.

Another form of slop-closet is Dr. Hill's, in use in Birmingham, and figured in the accompanying diagrams. (Fig. 5, I., II., and III.)

In the diagram a siphon cistern is shown to collect the slop-water, and discharge it in a sudden flush, but in practice this siphon cistern is not used, as it was found that the accumulation of stagnant slop-water gave rise to nuisance, and Dr. Hill considers that the arrangement works well without it, where the fall is good.

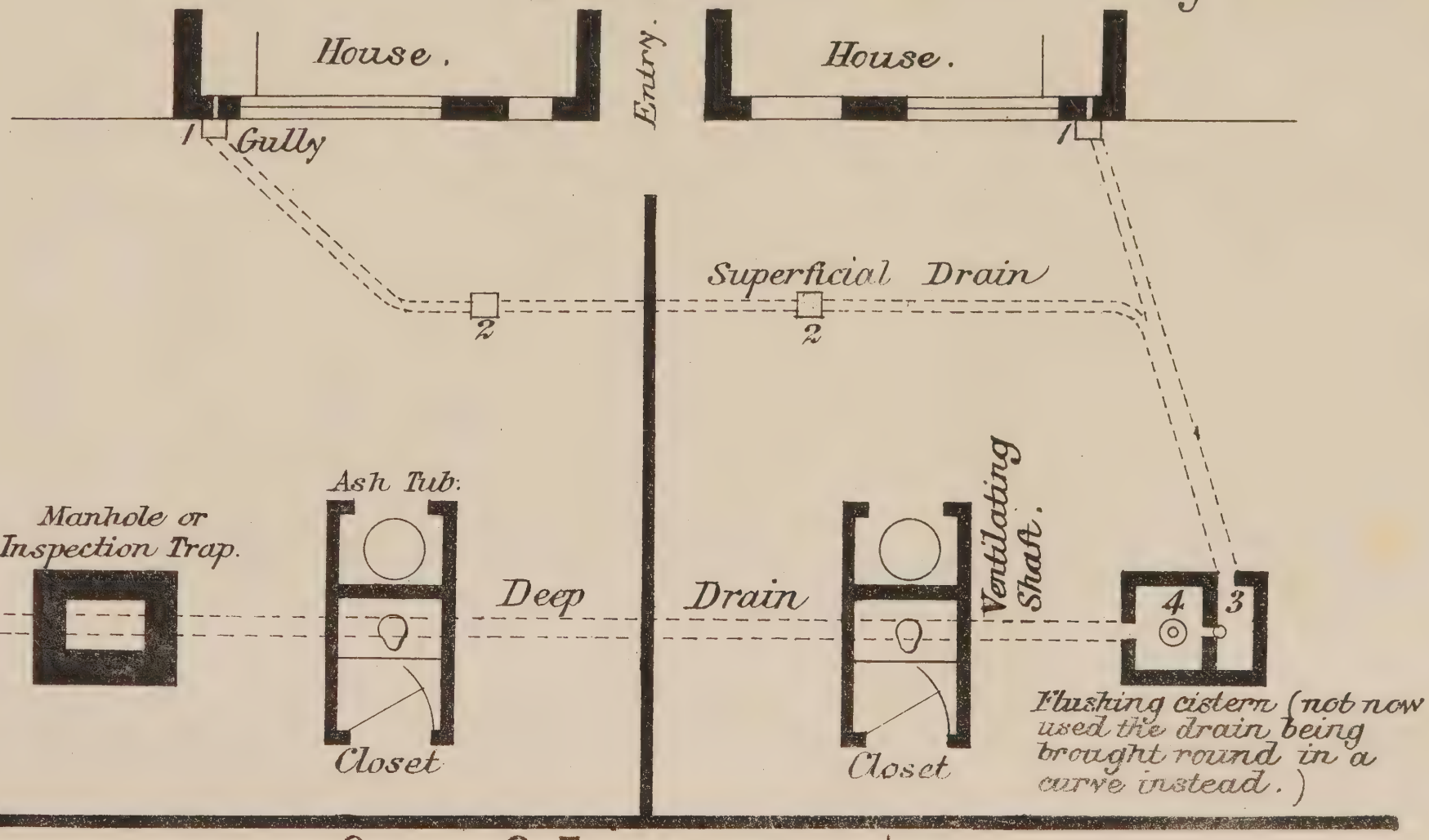
Where necessary Dr. Hill now recommends a "tipper" in preference to a siphon tank; as the latter when used with slop-water is liable in time to become clogged by greasy and soapy water, which interferes with the action of the siphon.

The chief difference between Dr. Hill's closets and Fowler's is, that in the former there is no trap under the closet shaft, but the excreta

# Dr Hill's Improved Flush Closets.

## I Plan.

*Fig. 5.*

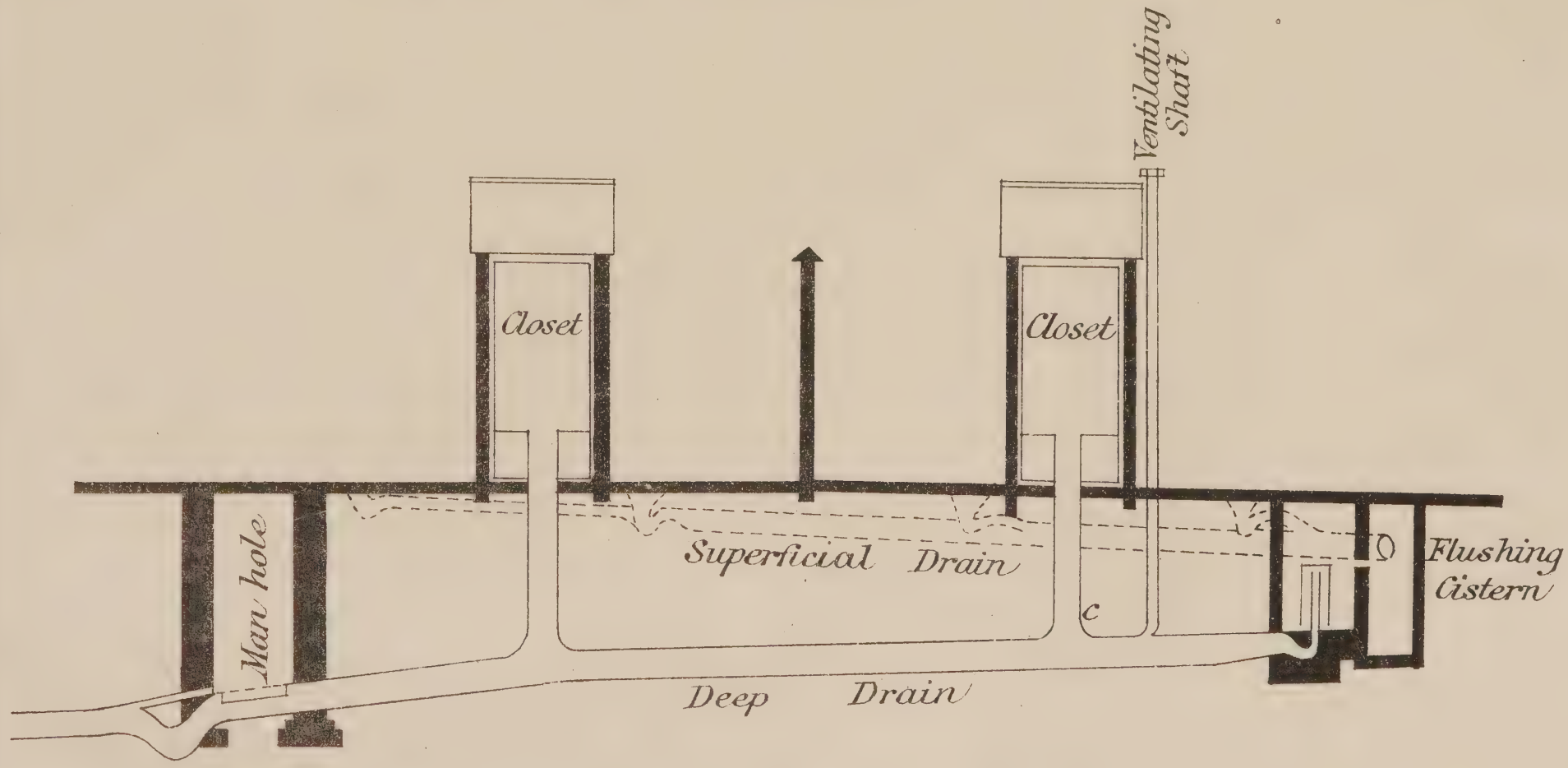



Scale 8 Feet to one Inch.

1882, 12. 90

To face p. 166.

*Fig 5.* **II. SECTION.**



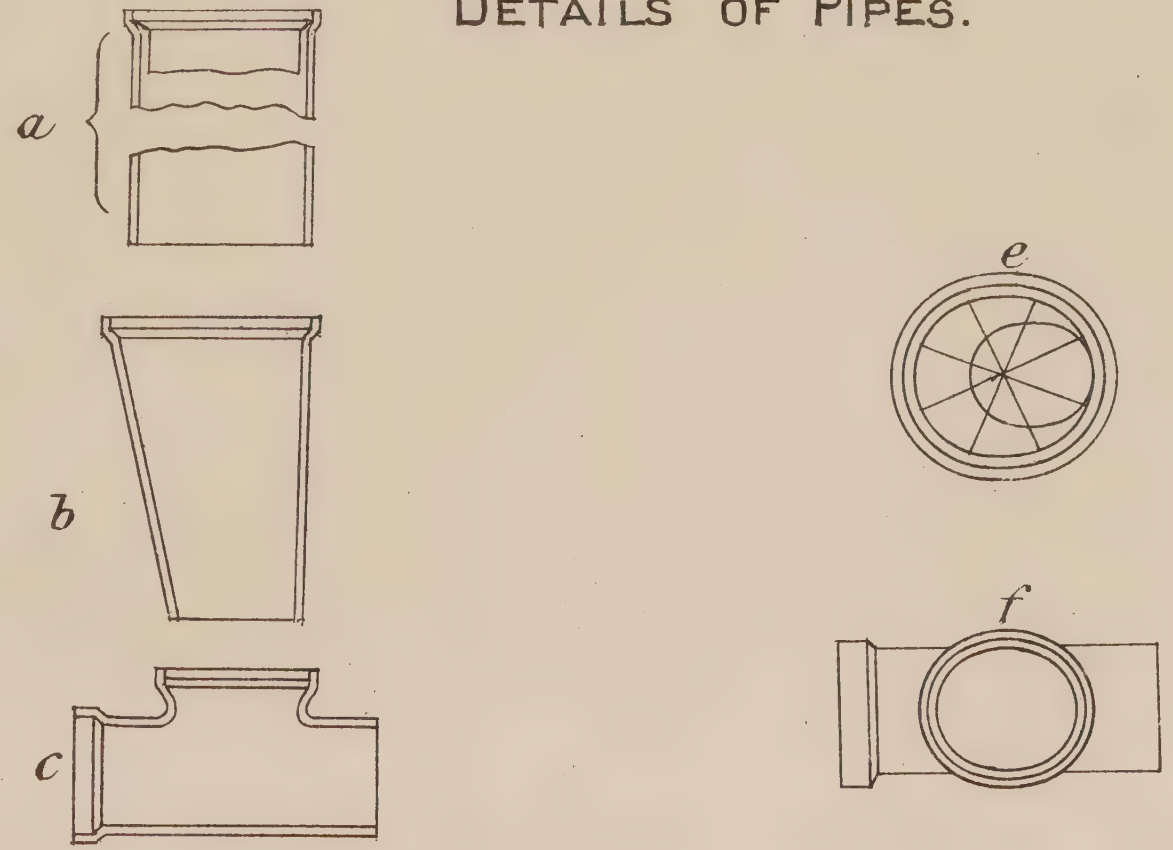

SCALE 8 FEET TO ONE INCH.

*To face p. 166.*

Judd & Co Lith. 73 & 75. Farringdon Rd & Doctors Commons 1882. 1.91.

III. *Fig 5.*

## DETAILS OF PIPES.




SCALE 2 FT TO ONE INCH.

*a. Upper pieces of shaft – Section.*
*b. Lowermost piece of shaft – Section.*
*c. Junction on drain Section.*
*e. Plan of b showing wire guard to intercept improper articles.*
*f. Plan of c.*

*To face p. 166.*

'882.12.90.

fall directly on to the bottom of the drain, which has at this point no dilatation or bend, to offer obstruction; they are therefore more readily dislodged and carried away by the flow of slop water than they are from the trap of Fowler's closet. There is a trap at the lower end of the drain, which is placed at the bottom of a manhole for convenience of access. A number of closets may be placed on one drain, a single trap serving for the whole. The drain is provided with a ventilation shaft in its upper part.

Some closets on this plan which I saw in Birmingham were fairly clean and free from offensiveness.

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Auxiliary contrivances for flushing.

A further important improvement was effected by substituting for the slow and uncertain trickle of the slop water from the sink an arrangement by which a quantity of slop water could be stored and discharged in a sudden gush.

For this purpose at least two different contrivances are available, viz., a "tipper," *i.e.*, a vessel so shaped and balanced upon pivots that, when full, the weight of the contained liquid overbalances it and causes its contents to be suddenly discharged; or a siphon tank. The latter contrivance is, however, rarely used for dirty water, and appears to possess no advantage over the tipper, while it is inferior to it in certainty and rapidity of discharge, and is at least equally likely to get out of order.

Neither the tipper nor the siphon tank are new inventions, both being described in Mr. Netten Radcliffe's report before mentioned; but in the instances there given their application was different; the siphon tank being used in connexion with sewage irrigation; the "tipper" or "tumbler" being employed to flush, with clean water from a tap, long ranges of trough closets.

The use of the "tipper" for the flushing of closets with slop water dates, however, so far as I can learn, only about four years back, and its employment for this purpose seems to be due to Mr. Slater, inspector of nuisances for Burnley, and Mr. Duckett, earthenware manufacturer, of the same town.

Burnley experience.

Burnley claims to be the native home of the automatic slop-closet: the system has been more largely adopted there than in any other town of which I am aware, and the works of the principal manufacturers of these articles are in that neighbourhood. I was told that before the publication of Mr. Netten Radcliffe's report already mentioned, the vault privy system, or "Lancashire cesspool," was in use in Burnley, but this system being found to cause an intolerable nuisance, the Sanitary Authority, having Mr. Radcliffe's report before them, selected for experimental trial two of the systems therein described, viz., the "pail system" and the "Bristol eject." I did not, however, see any closets at Burnley constructed after the Bristol pattern, and those which were called "Bristol ejects" or "Fowler closets" were constructed as at Southport, the slop water being led into them by a drain.

> The "Lancashire cesspool"* consists of a middenstead divided horizontally by a flag floor: the upper compartment being used for ashes and dry refuse; the lower one being a vault in connexion with the privy. In emptying it the ashes are first removed and placed in a cart; the flag floor is then taken up, and the night-soil is

---

* It may be noted that the word "cesspool" has at least three different meanings in different parts of the kingdom; its use in Lancashire and Staffordshire being different from that in Lincolnshire and some parts of Yorkshire on the one hand, or in London on the other.

ladled out and placed in the cart, the ashes having been so disposed as to form a hollow for its reception. The vaults are deep, and their contents wet and offensive, and when constructed, as they were formerly, of brickwork, there was necessarily soakage of foul matter from them into the subsoil, but an improvement has been effected by constructing the tank of earthenware in one piece; this prevents soakage, and keeps the receptacle for excreta within moderate dimensions, its capacity being 8 to 9 cubic feet.

The pail system is not popular in Burnley. The contents of the pails are often wet and offensive, owing to the habit which prevails of pouring slop water into them, and in scavenging them it is the practice merely to empty the contents into a cart, and to replace the pails without cleansing. The system is, nevertheless, very expensive in working; costing, in houses where it is in use, about 1*s.* 1*d.* per head per annum; this is due partly to the hilly nature of the ground on which the town stands, causing extra expense in carting, partly to the circumstance that there is a difficulty in disposing of the night soil; there being no arable land in the neighbourhood, and the neighbouring authorities objecting to its use on grass land in populous localities.

The treatment of the sewage, by precipitation with lime and drying of the sludge in filter presses, costs on the other hand only 5*d.* per head per annum, and the facilities for sewerage afforded by the good gradients in the town have aided the development of the water-carriage system, while a somewhat limited supply of water (now, however, about to be extended) has favoured the use of slop-closets with a view to economizing the town water.

The number of closets of different kinds in Burnley at the time of my visit was given me as follows:—

| | | | | |
|---|---|---|---|---|
| Slop-closets | Duckett's | 2,287 | | |
| | Whalley's | 238 | | |
| | Hocking's | 189 | | |
| | Brooks and Pickup's | 128 | | |
| | Clayton's | 66 | | |
| | Whittaker's | 26 | | |
| | Fowler's and others | 1,432 | = | 4,366 |
| Trough-closets | | | | 943 |
| Cistern waterclosets | | | | 5,371 |
| Total waterclosets | | | | 10,680 |
| Privies with wall tanks | | 1,734 | | |
| ,, ,, earthenware tanks | | 5,136 | | 8,217 |
| ,, ,, pails | | 1,347 | | |
| Total privies and closets | | | | 18,897 |

The Health Committee have since decided that the following are the only kinds of closet which they will sanction:—

Duckett's arrangement A or B, with 3-gallon tipper.

Duckett's ,, C, with 5-gallon tipper for two closets only.

Duckett's trough-closets, hand-flushed.

Brooks and Pickup's (Whalley's) closet with 3-gallon tipper, either automatic or lift-up.

Hocking's closet, with 3-gallon tipper.

There are 19,000 houses in the borough; some of the larger houses and the mills have more than one closet each, and in the older and poorer quarters of the town one closet may serve for more than one

house, but as a general rule each house has its own closet in a separate backyard. The inhabitants are mostly of a well-to-do artizan class.

The slop-closet system was at first often found to fail in that the drains frequently became stopped up, sometimes owing to their having been improperly laid, or to improper substances having been thrown down the closets, but especially owing to the force of the stream of water not being sufficient to carry away the excreta and paper. It was to remedy this that the "tipper" was introduced, and it appears to be effectual when the closet is properly designed and constructed. On examining a number of slop-closets in Burnley and elsewhere, I found that while those without the tipper were rarely free from an accumulation of excrement at the bottom, those furnished with a well-acting tipper, and a good-shaped pan, were quite free from any such lodgment. An owner of cottage property in Burnley told me that having tipper-closets at some of his houses, and Fowler's closets at others, he found the latter get out of order very much more frequently than the former.

The complete success of the system, however, depends upon careful attention to details, both in the design and in the fixing of the apparatus.

In the designing of these articles much ingenuity has been shown, and in examining them I could not help thinking that the wish once expressed by the Registrar-General that Lancashire would devote some of the admirable ingenuity which it expends upon cotton spinning to the promotion of the health of its inhabitants had been in this matter fulfilled.

Forms of automatic slop-closets.

There are many varieties of automatic slop-closets, as there are a number of makers of such articles, and some makers make more than one pattern; and, again, some makers have introduced modifications and improvements, so that their closets, as now made, are different from those fixed two or three years ago. The varieties, however, may be classed under one or other of the following types:—

1. Those in which the basin and trap of the closet are at the bottom of a deep shaft, the water being conveyed into them by an underground drain. These may be called "bottom-flushed."
2. Those in which the basin and trap are close under the closet seat, the tipper being above ground, and supplied direct from the slop-stone pipe. These may be called "top-flushed."

1. Bottom flushed. Points to be attended to.

1. The following remarks have reference to the first of these types. In these closets the following features have especially to be considered:—

(*a.*) the tipper;
(*b.*) the closet shaft;
(*c.*) the basin and trap.

(*a.*) the tipper.

(*a.*) The tipper should hold at least three gallons. The Burnley Corporation decline to sanction any of less capacity. I saw some older closets there of Clayton's pattern, which had tippers of only two gallons capacity, but the flush (which was thrown in a direction away from the pan and had to flow back into it) was insufficient to keep the closet basin clean. The capacity of the tipper should considerably exceed that of the closet trap, in order that the contents of the latter may be thoroughly washed out at each discharge. The tipper is made of glazed earthenware, of japanned cast iron, or of galvanized wrought iron. Earthenware is cleaner, as congealed grease is less apt to adhere to it than to iron; it is, however, more liable to fracture, and a small breakage, which allows the water to escape before the vessel is quite full, destroys the action of the tipper. In practice, however, this

accident rarely occurs; as the tipper is placed underground out of harm's way, and india-rubber buffers or steel spring are fixed to prevent its being damaged by its own concussion. The pivots of the tipper and the bushes in which they work should be made of brass or gunmetal to prevent rust. The earlier ones were made with iron axles, and frequently got fixed through rusting.

The position of the tipper may vary. In Duckett and Son's "arrangement A" shown in plan and section in Fig. 6, the tipper is placed close under the slop-stone pipe, being enclosed in an earthenware box, covered with a dish-stone with a grating fixed by brass screws.

In "arrangement B" (Fig. 7), which is especially adapted for closets which are at a considerable distance from the slop-stone, the tipper-box is in a piece with the lowest section of the closet shaft, and the tipper discharges direct into the closet basin.

Either of these arrangements will work satisfactorily; the choice between them being a question of adaptation to particular places. It will be observed that in A there is no trap between the closet and the dish-stone over which the slop-stone pipe delivers. It would, I think, be better to trap the slop-stone pipe* (in the diagram shown untrapped), and also to make it deliver over a short channel leading to the inlet, instead of directly over it. I did not, however, hear any complaints of smells arising from the inlet above the tipper, except where the closet was out of order through chokage of the drain below it. The action of the tipper keeps clean the length of drain between it and the closet, and the inlet-drain and closet-shaft together form an inverted siphon, of which the latter is usually the longer vertical leg, so that it would ordinarily serve as the up-cast. A trapping bend might be inserted in the course of the drain between the tipper and the closet, but would weaken the flush. Or a gully trap might be fixed over the tipper, but this would diminish the fall available for the drain, and in practice it is found that gully traps are apt to be neglected, and that the accumulation of sediment in them gives rise to nuisance, whereas the tipper cleans itself. The best plan, would, I think, be to fix a ventilation shaft from the drain up the wall of the closet to end above the roof, as shown in the diagram of Dr. Hill's closet.

Another form of tipper is the reversing double tipper of Messrs. George Clarke and Sons, of Rishton, shown in section in Fig. 8.

This has two compartments, each holding three gallons, and acting alternately, so that when one is filling, the other is empty, and when the first discharges itself, the second is brought into position to be filled. It is claimed for it that it is less likely to be deranged in its action than a single tipper, and that the discharge being thrown alternately forwards and backwards, there is less likelihood of matters lodging in the back of the tipper-box. An experimentally arranged apparatus acted very efficiently, but it did not appear to me to have any advantage over the ordinary form of tipper commensurate with its increased dimensions.

In Whalley's patent waste-water flushing closet (makers, Brooks and Pickup, Burnley) shown in the annexed sketch, the tipper is not self-acting, but is discharged by pulling up a handle, as in the old-fashioned

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* I find much diversity of opinion among medical officers of health as to whether the slop-stone pipe should be trapped as well as disconnected from the drain. My own opinion is decidedly that the slop-stone pipe, even though discharging in the open air, should be trapped in all cases, but especially when of any considerable length, as otherwise offensive effluvia from the fur with which the inside of the pipe gets coated are drawn up into the house.

*Fig 6.*

# DUCKETTS PATENT AUTOMATIC W. C.

## FLUSHED WITH SLOP WATER

### ARRANGEMENT A.

PLAN ON LINE A — B.

To face p. 770

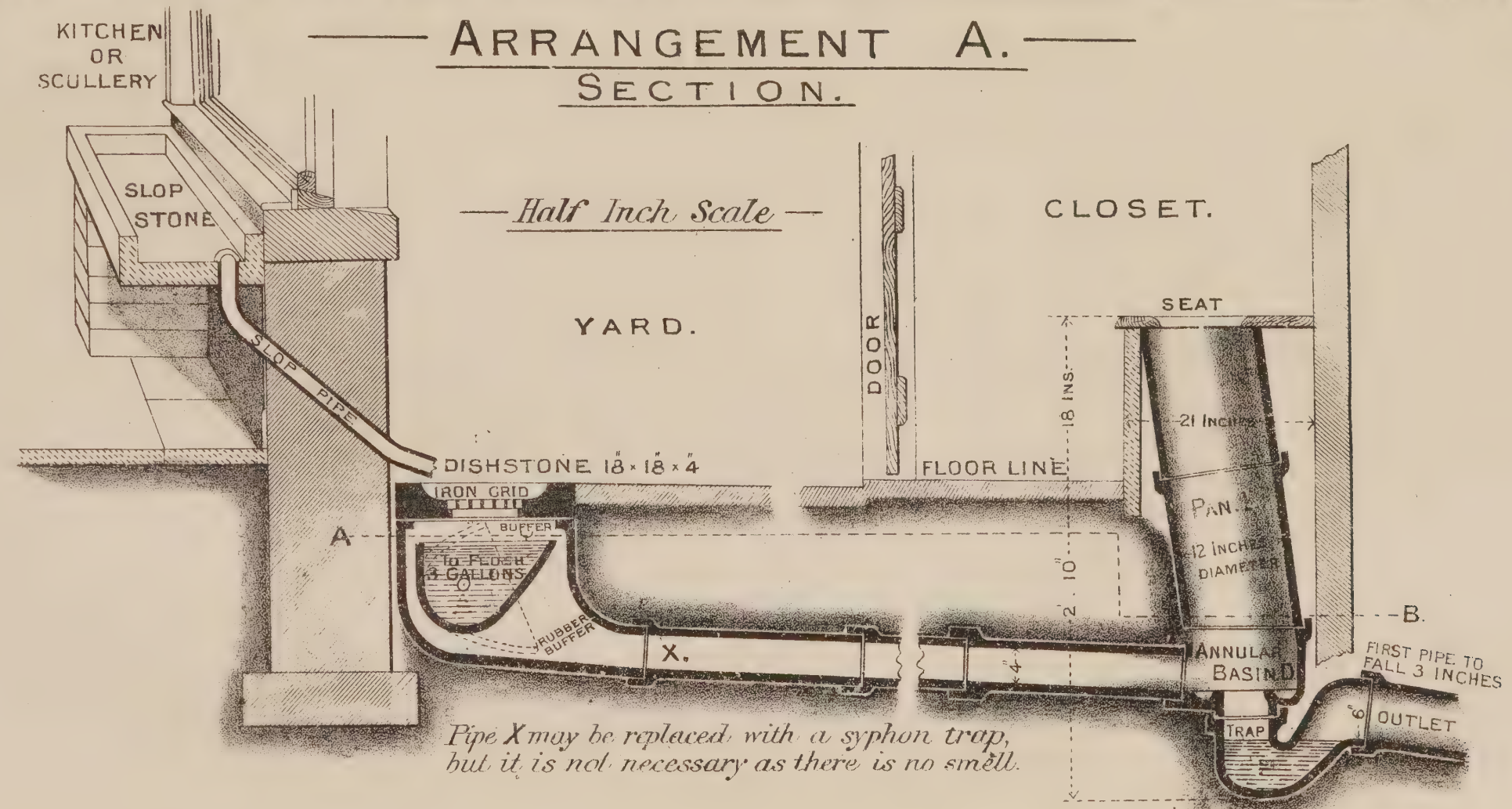
Judd & Co Lith. 73 & 75, Farringdon Rd & Doctors' Commons

*Fig. 6.*

# DUCKETT & SON'S PATENT AUTOMATIC CLOSET FLUSHED WITH SLOP WATER

## — ARRANGEMENT A. —

### SECTION.




*Pipe X may be replaced with a syphon trap, but it is not necessary as there is no smell.*

*This trap and basin may be turned in any direction to suit the drains.*

*To face p. 170*

*Fig. 7.*

# DUCKETT & SON'S PATENT AUTOMATIC CLOSET FLUSHED WITH SLOP WATER.

## ARRANGEMENT B.

*Scale ½ Inch to a foot.*

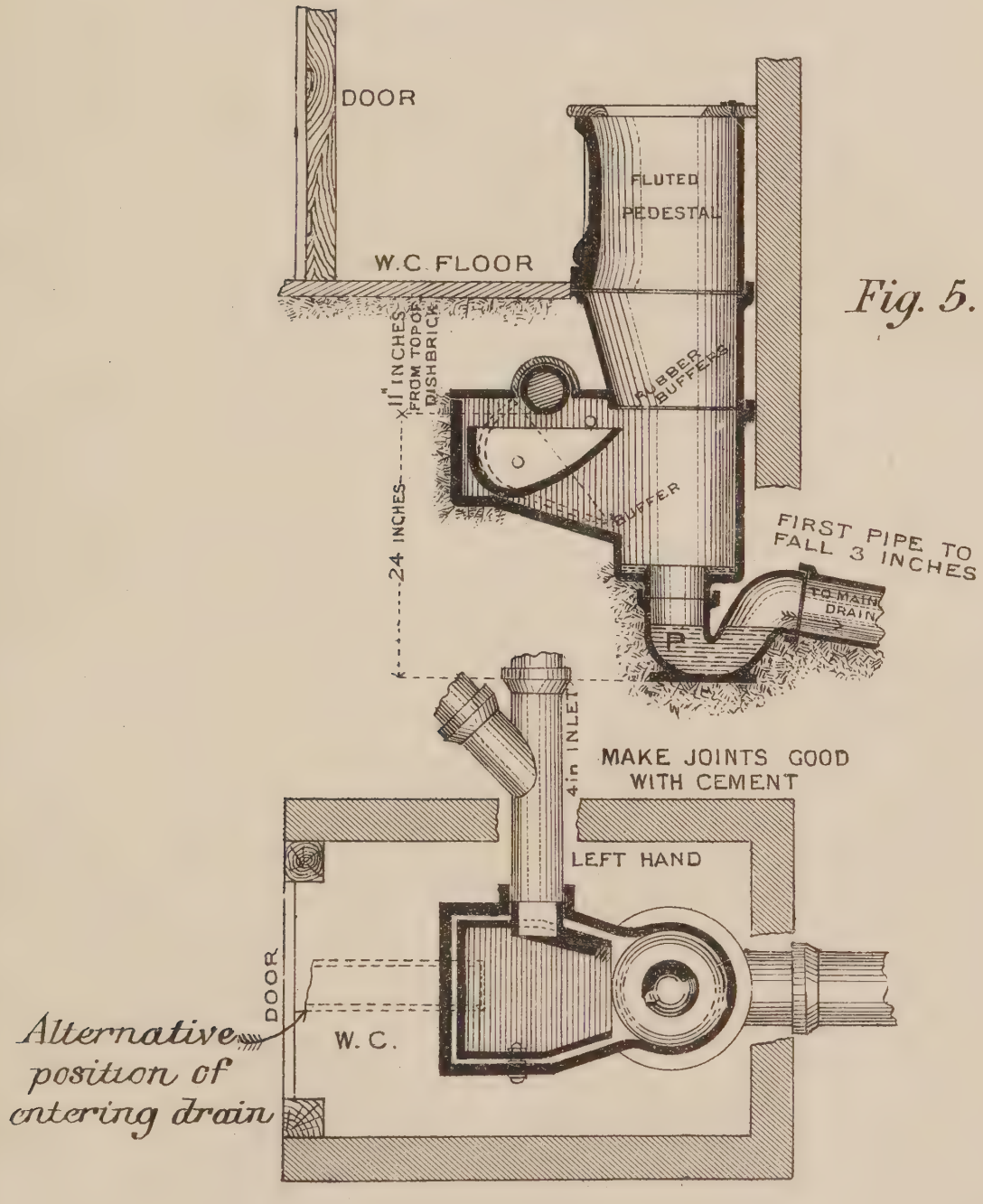
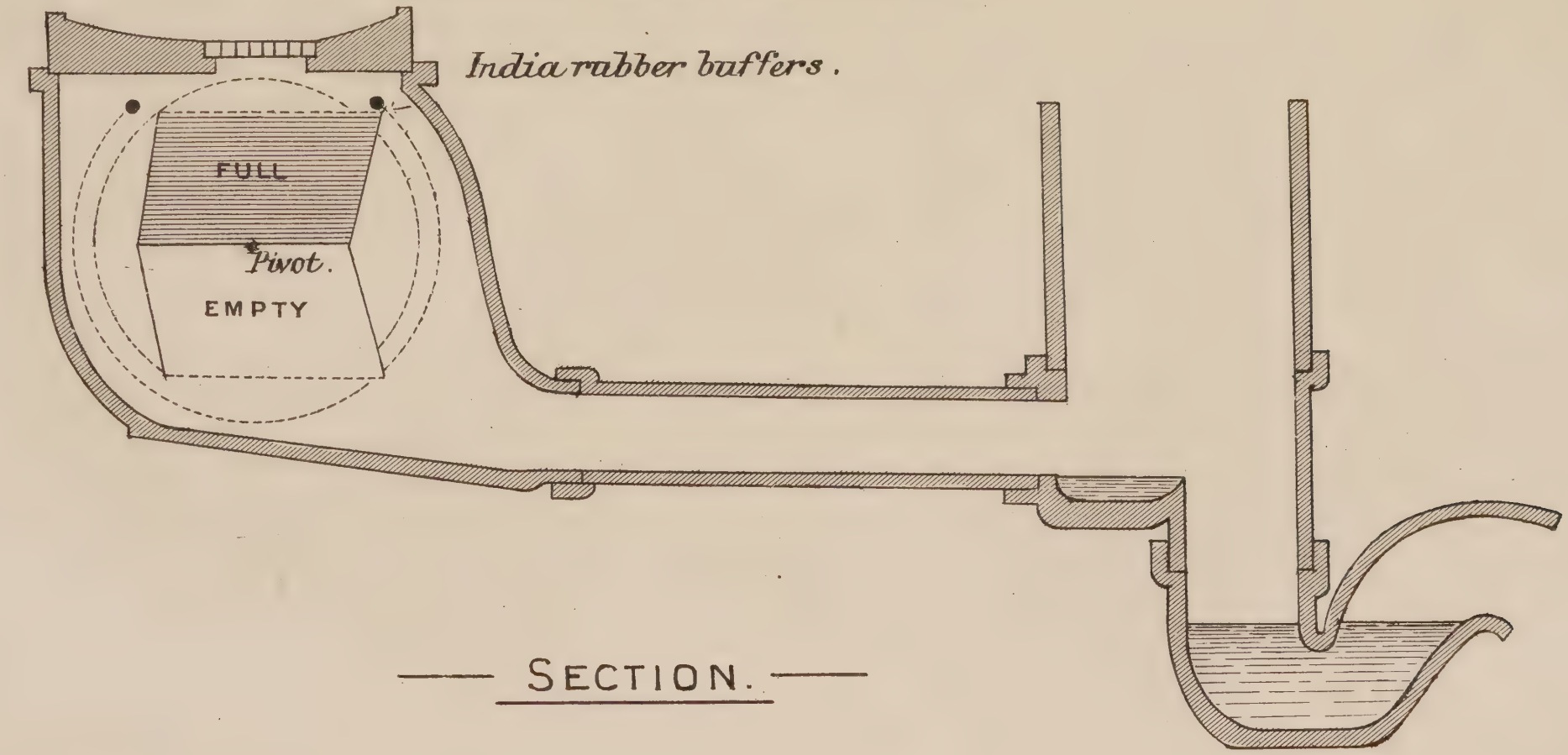



*Fig. 5.*

Judd & Co Lith. 73 & 75, Farringdon Rd & Doctors' Commons.

Fig 61. GEORGE CLARKE & SONS'.

# AUTOMATIC REVERSING DOUBLE TIPPER TO FLUSH 3 GALLONS EACH DISCHARGE.




SECTION.

*Scale 1 inch to a foot.*

Judd & Co Lith



To face p. 170.

pan watercloset. If not discharged by hand the water overflows in a dribble through the closet, which thus becomes virtually a Fowler's closet. These closets have the disadvantage of leaving the flushing to

Fig. 9.

Whalley's Patent Waste-water Flushing Closet.

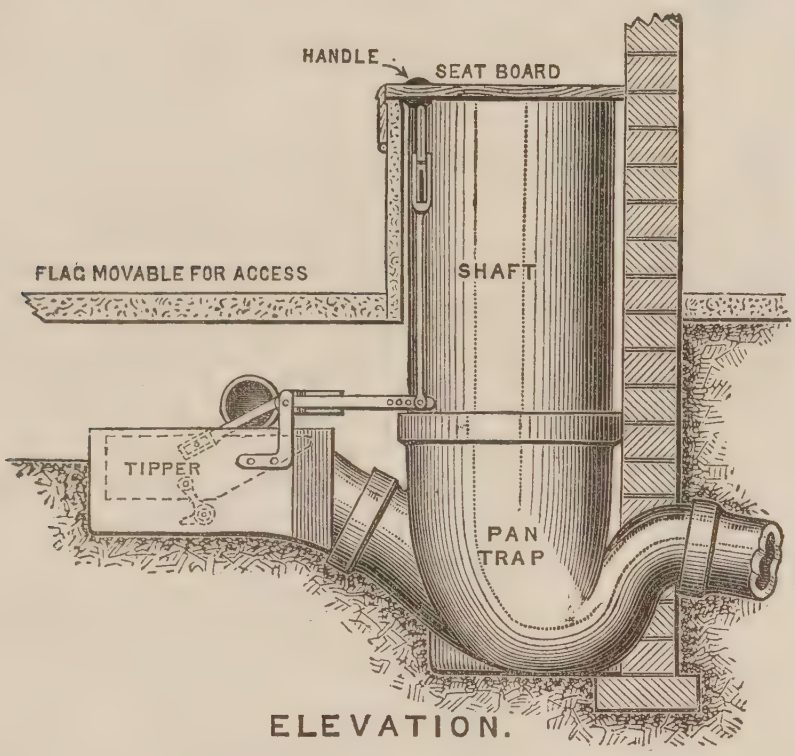
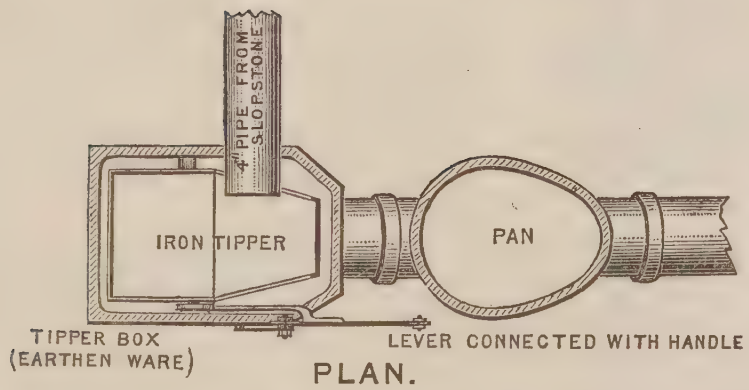



Fig. 10.




individual care instead of doing it automatically, but they are said by the authorities at Burnley to act well, and rarely to get out of order.

A well-made automatic tipper, however, appears to be little liable to get out of order. I saw some that had been fixed three years, and were still in working order, having required no attention. Of course, if the drain get stopped, so that the tipper-box is filled with sewage, the tipper will not work. I saw a few in this condition, but in all of these the stoppage was below the closet, in the drain or trap. (Such stoppages are usually found to have been caused by improper articles being thrown down the closet.)

A single tipper may be made to flush two, or even three, closets in a row, but in this case the tipper should be of larger capacity (five gallons), and the flush is not so effectual as where each closet has a separate

tipper. This arrangement, shown in Fig. 11, approximates, it will be seen, to a trough-closet. Mr. Duckett informs me that he finds the flush more effectual, if the connecting pipes between the several basins are made oval in section, with the long axis horizontal, than if the connecting pipes are cylindrical.

or siphon tank.

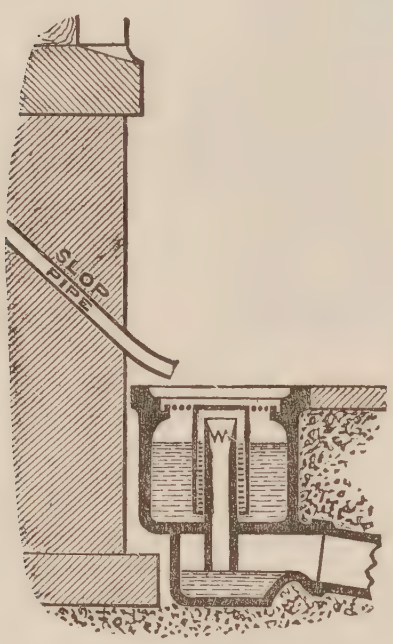
Instead of a tipper a siphon tank may be used. In the construction of a siphon tank the chief problem to be solved is to make the siphon of sufficient calibre to discharge a full stream of water and at the same time to make it to start with certainty when only a small stream of water enters the tank. In proportion as we increase the calibre of the siphon compared with the volume of the entering stream, do we also augment the difficulty of making the siphon start itself spontaneously.*

Duckett's siphon tank, which I saw in use in a few places in Bradford, is here figured. Fig. 12.

It is an earthenware tank, discharging four gallons. The siphon is formed by two concentric pipes, the upper orifice of the inner pipe being furnished internally with a projecting conical toothed lip. When the tank is full the drops of water falling from the points of this lip extract the air and start the siphon. A thread, however, hanging over the lip will sometimes conduct the water down the side without starting the siphon, and congealed grease will interfere with its action. One of those seen at Bradford could not be started by the ordinary trickle from the sink-pipe. The outer pipe is fixed to the grating like a very deep bell-trap, and is liable, like that contrivance, to injury. The flush is much less sudden than that of the tipper, beginning gradually and requiring some seconds to attain a full flow. There is also the liability of sediment accumulating in the tank, unless care be taken to keep it cleared out from time to time.

Fig. 12.

Duckett's Siphon Tank.




Empsall and Fish's patent siphon flusher (Fig. 13), made by Whittaker of Blackburn, combines the action of the siphon and tipper, and is more sudden in its action than the above, discharging four gallons in about seven seconds. The siphon is an earthenware pipe, oval in section, 4 by $2\frac{1}{2}$ inches, and made in a piece with the tank. The lower end dips into an earthenware cup, which turns on a pivot but is kept in place when empty by a counterpoise. When the tank is full the water overflows into the cup, which, when full, falls by its weight and leaves a column of water unsupported in the long leg of the siphon; and this column by its fall starts the siphon. The action is more sudden than in the ordinary siphon tank, and apparently more certain, starting even with a drop-by-drop supply. When the tank is empty and the discharge ceases, a notch in the lip of the cup allows the water in it to escape;

* For the conditions to be fulfilled see papers on "Self-acting intermittent siphons," by Mr. Rogers Field, C.E., and Dr. Francis Bond, in the "Sanitary Record" of December 15th, 1879, and February 15th, 1880. The impurities present in slop-water render the action of a siphon less certain with it than with clean water. They are not so likely to interfere with the action of a tipper.

# ARRANGEMENT C

*Fig. 11.*

HALF INCH SCALE.

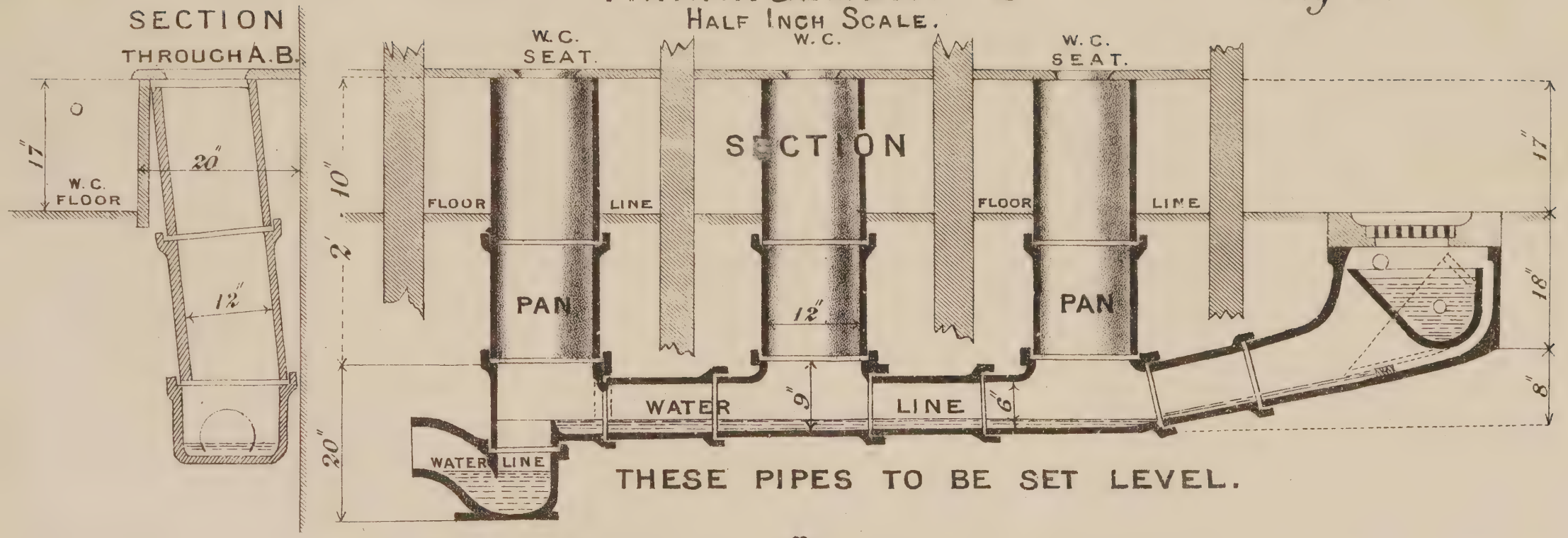
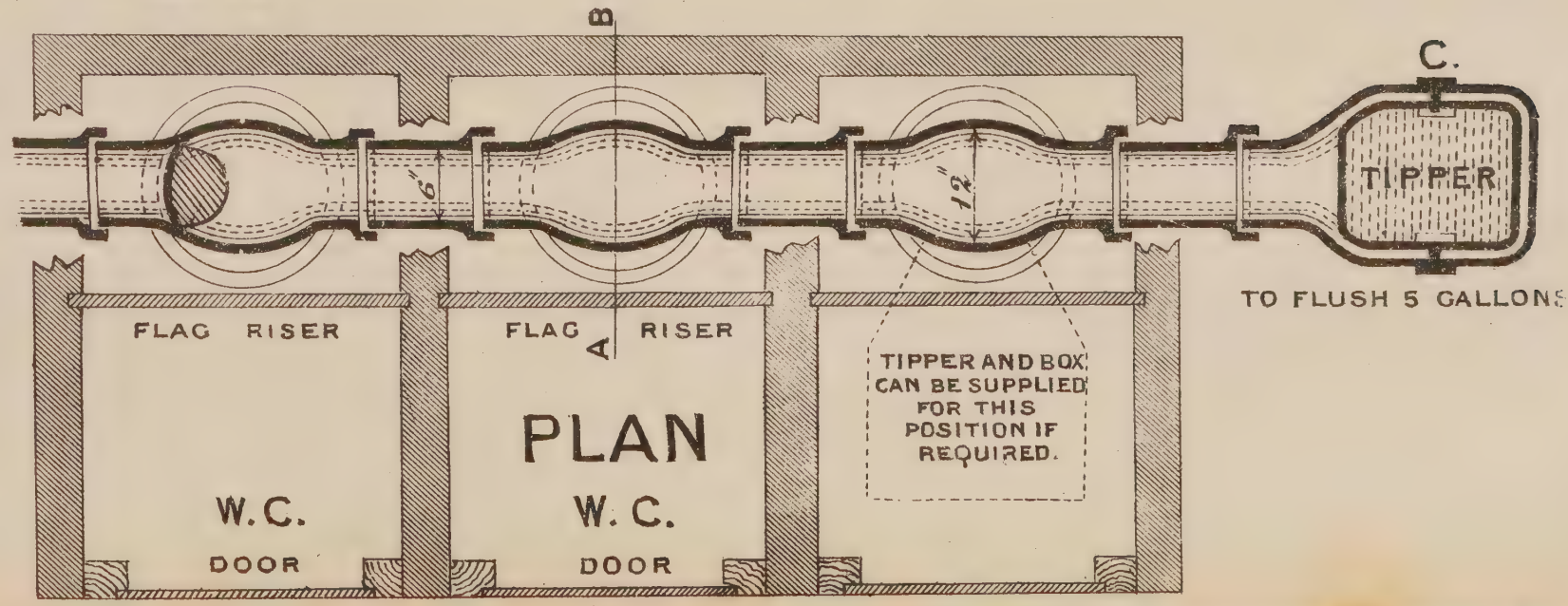



DIAGRAM SHEWING ARRANGEMENT FOR FLUSHING 2, 3, OR 4 CLOSETS WITH A 5 GALLON TIPPER.




Judd & Co Lith 73 & 75 Farringdon Rd & Doctors' Commons 1882. I. 91

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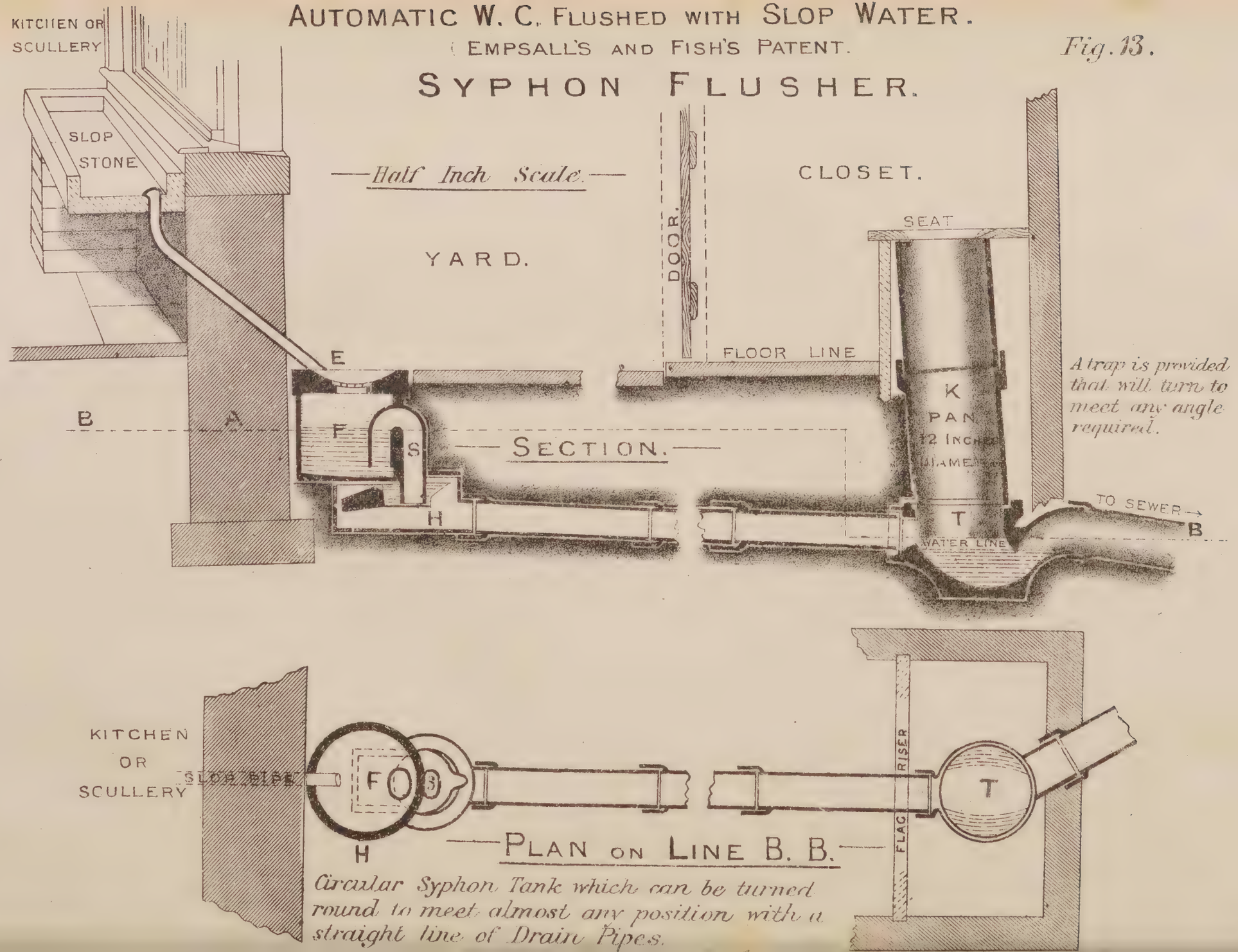
# AUTOMATIC W. C. FLUSHED WITH SLOP WATER.

( EMPSALL'S AND FISH'S PATENT.

*Fig. 13.*

## SYPHON FLUSHER.




To face p. 17

air then enters the siphon and interrupts its action, and the cup rises into position ready for the next discharge.

(*b.*) In the construction of the "trunk" or upright shaft of a bottom-flushed slop-closet, the chief point is to avoid fouling of the wall of the shaft by excretal matter falling on it, especially at the back. In an ordinary watercloset of good design, and with a good supply of flushing water, any excretal matter lodging on the sides of the pan is washed off and carried away by the flush, but in a closet of the kind we are considering, the shaft if foul must be cleansed by manual labour, and this is a task which is apt to be neglected by the occupants of cottage property, for which these closets are especially used.

(*b.*) the shaft.

To avoid this fouling there should be no contraction in the diameter of the shaft above the point at which the water enters. The shaft, if cylindrical, should be not less than 15 inches in diameter, the hole in the seat being smaller and placed well forward. In some patterns the shaft is made oval in section, with the long diameter from front to back; but the drawback to this form is that it is more difficult to make a perfect fit between oval pipes than between cylindrical ones, and a projecting ledge affords opportunity for excrement to lodge. The most successful device appeared to me to be that of making the shaft slope backwards from the seat as shown in Figs. 6 and 13, so that excrement may fall clear of the back wall.

The shaft is usually made of brown salt-glazed ware, in lengths, with socket joints. White-glazed earthenware would facilitate cleanliness, being smoother and enabling dirt to be more readily seen, but it would add somewhat to the cost.

A rough or porous material, like the brickwork formerly used at Bristol, is unsuitable.

(*c.*) In the construction of the basin and trap at the bottom of the shaft the points to be aimed at are that the basin shall be of such a shape that its contents shall be carried clean away by the flush of water, and that the trap shall be of the least practicable capacity, and at the same time afford no unnecessary obstacle to the flow through it.

(*c.*) the basin and trap.

A simple and effectual arrangement is that in the Birmingham closets, shown in Fig. 5, in which the excreta fall simply on to the bottom of the drain, the trap being an ordinary trapping bend at a distance. In an earlier pattern the drain was widened out at the point of junction of the closet shaft; but this dilatation was found to retain fœcal matter, and it is now avoided by making the junction oval as shown.

From a capacious basin-trap, of the form adopted in some of the earlier forms of slop-closet,—in one example seen and measured the trap had a capacity nearly as great as that of the tipper ($13\frac{1}{4}$ and 15 pints respectively)—excrement and paper are with difficulty completely removed even by the flush from a tipper. Where the flushing depends only upon the ordinary dribble of water from a sink, without the intervention of a tipper, such a trap, so far as my observation goes, is rarely clear of retained excrement and paper. In such closets the current of water passes under floating matters without carrying them away.

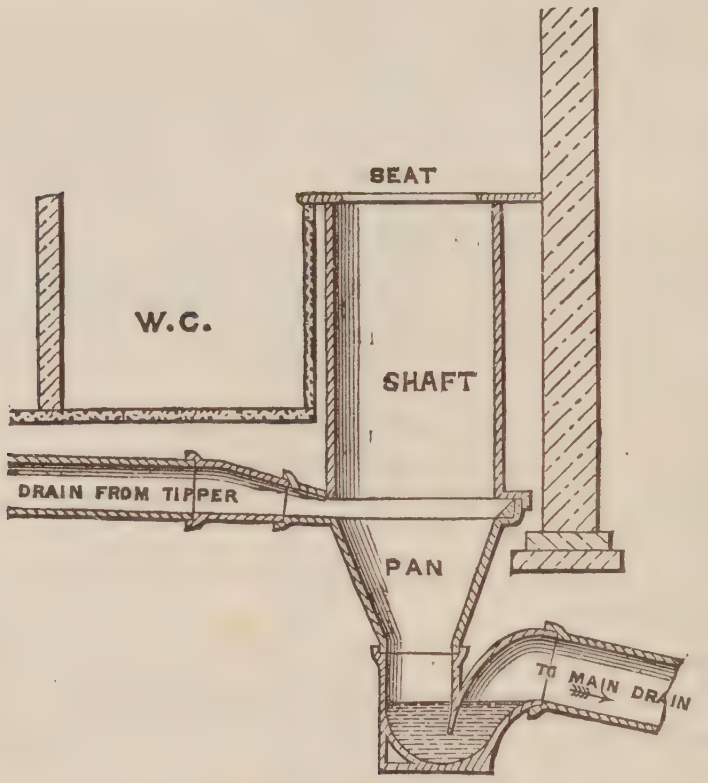
The most effectual arrangement seen by me appeared to be the annular basin in the closets now made by Duckett and Son, and shown in section in Figs. 6 and 7. In arrangement A, where the tipper is at a distance from the closet, the discharge from the tipper enters the pan at a tangent, and, after circling round it, is directed into the orifice in the centre by a stop; this gives a powerful whirlpool action, which completely clears the pan of all matters that will pass the orifice, whether lighter or heavier

than water. In an experiment a large quantity of dry grass, enough to fill the basin, was completely removed by one discharge of the tipper.

Other forms of basin, which were found to be effectually cleared when used in conjunction with a tipper, were that with a weir shown in the figure of Duckett's arrangement C, (Fig. 11), and the conical basin with a flushing rim, of Hocking and Son, Burnley, here shown.

Fig. 14.

Hocking's Closet.




The latter, however, has the drawback of requiring an additional depth of 18 inches in setting.

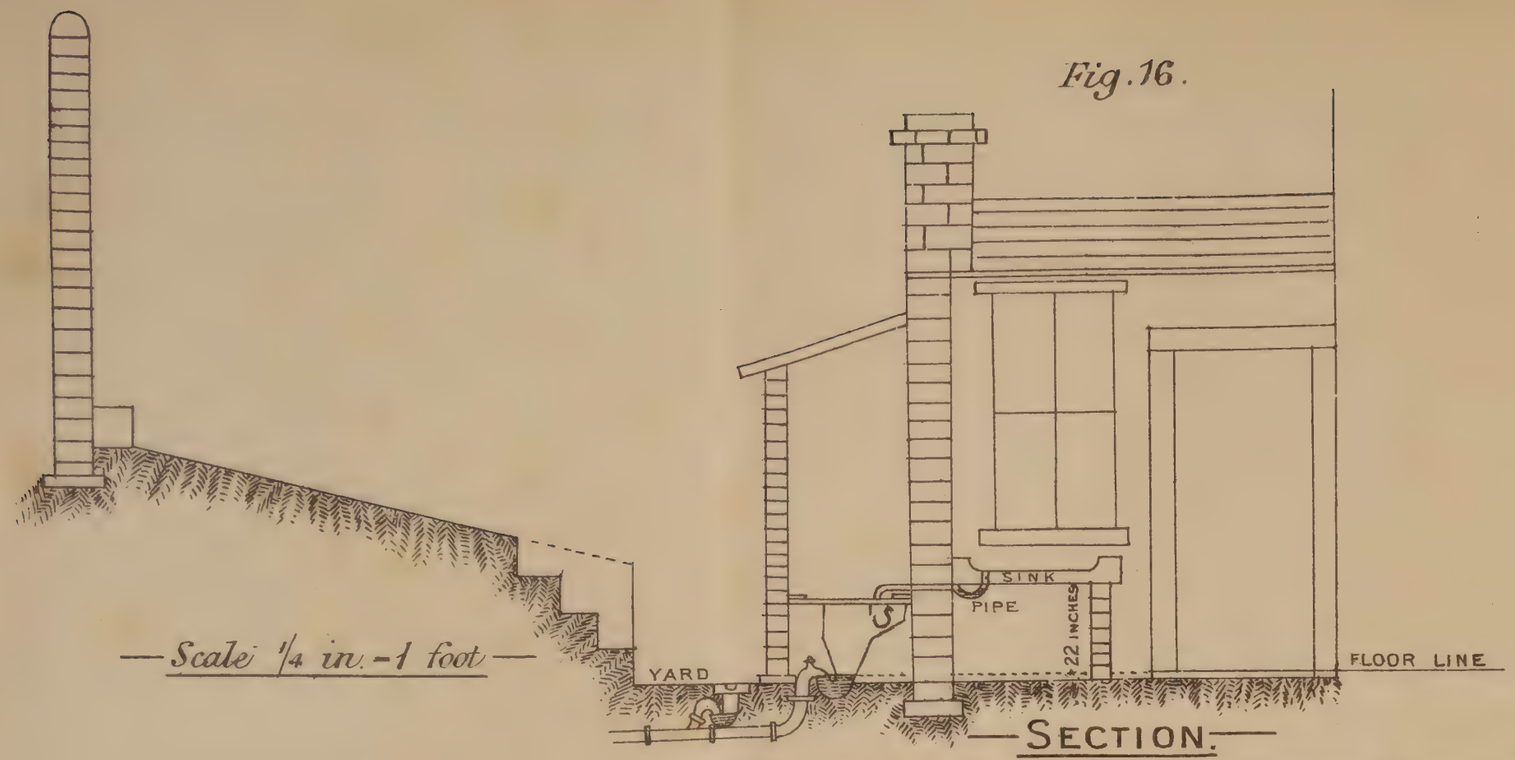
The drain from the closet should have a good fall, and be well jointed with cement, and the makers recommend that it should be not less than 6 inches in diameter.

2. Top flushed slop-closets.

2. The form of closet in which the tipper is above ground is especially adapted for situations in which the ground rises at the back of the house, so that there is a difficulty in getting sufficient fall for a closet of the other kind. In such situations the closet adjoins the kitchen or scullery, and the slop-stone pipe is led to discharge directly into the tipper. This arrangement hardly complies with the requirement of the model byelaws, that the slop-stone pipe shall discharge in the open air, over a channel leading to a trapped gully, but it is recommended by the makers of these closets that the slop-stone pipe should be trapped in order to prevent any foul odours from the closet being drawn into the house.

Two patterns of closet of this description were seen by me in use in the towns I visited. That of Messrs. Wright and Sutcliff of Halifax has a pan similar in shape to that of an ordinary watercloset of the "wash-out" kind, but with an opening at the back leading from a chamber in which the tipper is situated. The tipper is of galvanized

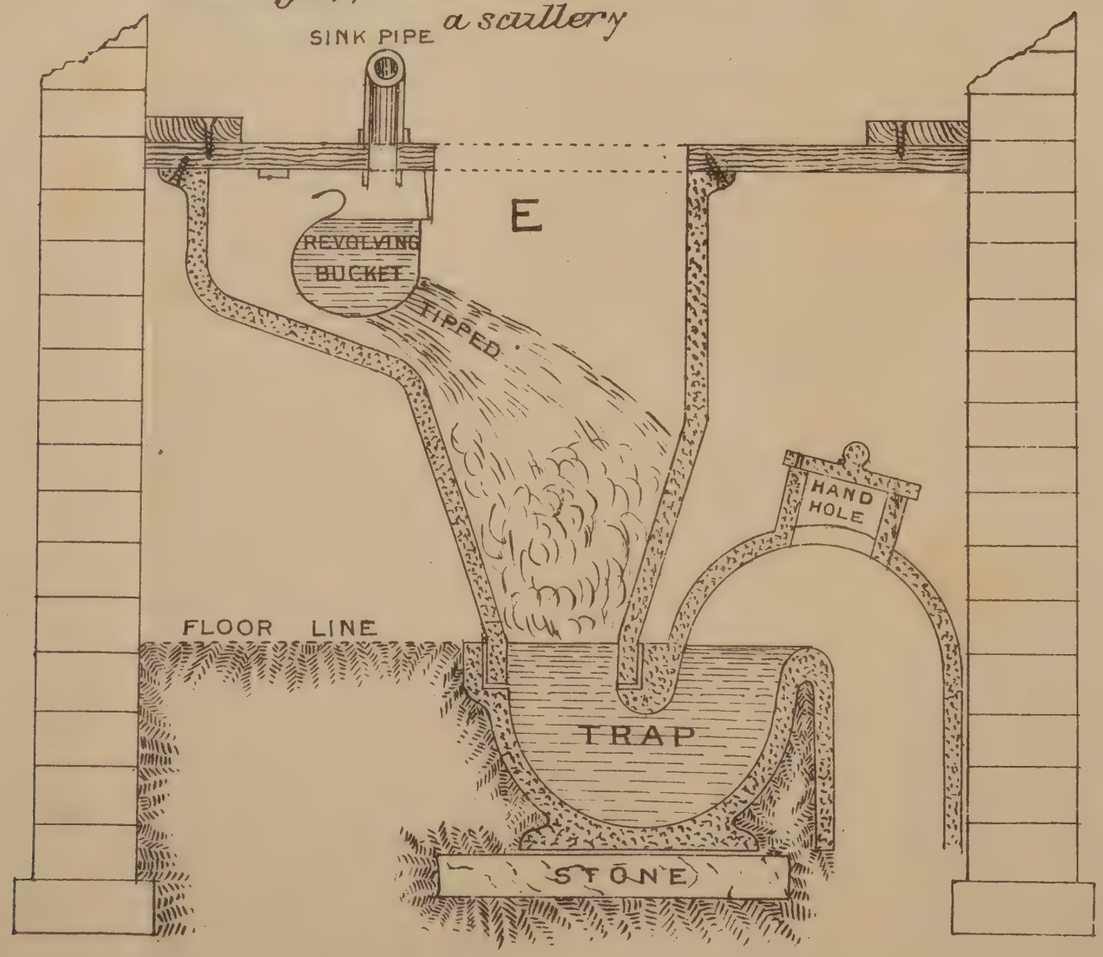
Fig. 16.




Scale 1/4 in. = 1 foot

SECTION.

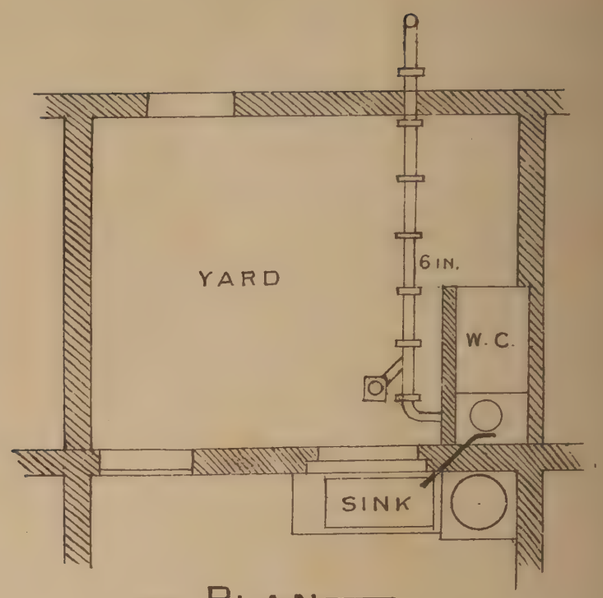
Shewing application of closet where there is a scullery




SECTION.

of Closet with tipper at side of seat.

1/8 Scale, 1 1/2 inch to a foot.




PLAN

Shewing application of Closet without Scullery

Scale 1/8 in. = 1 foot.

Seat in pedestal form with tipper at the back.

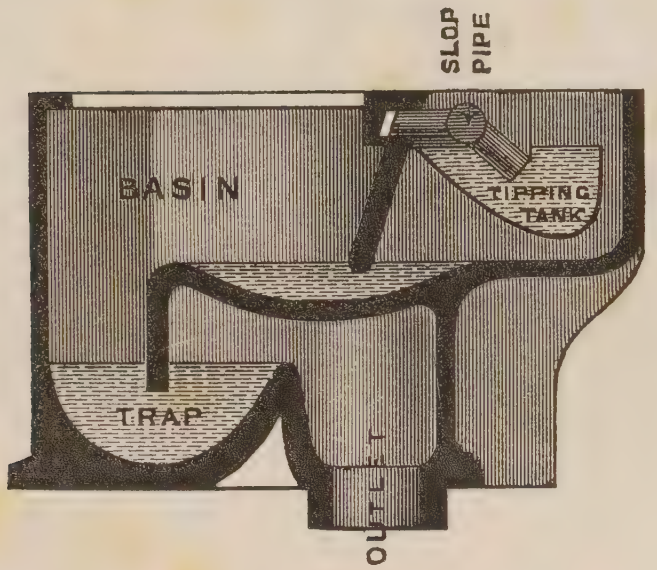
HINDLE AUTOMATIC SLOP VALVE.

Judd & Co Lith. 73 & 75, Farringdon Rd & Doctors' Commons.

iron and of one gallon capacity. The discharge from the tipper, which is spread out over the bottom of the pan, brush-fashion, has little force,

Fig. 15.

Wright and Sutcliff's Closet.




only just sufficient to wash the excreta out of the pan, but not sufficient to carry them at the same time through the trap. In all the closets of this kind seen by me there was a dark slimy deposit on the surface of the pan in the bottom where the water stood in it.

Hindle's closet (Blackburn), illustrated in Fig. 16, has a pan narrow in front, but wide at the back, where the tipper is situated, and well tapered downwards into the trap. The tipper is of galvanized iron, 16 inches long from pivot to pivot, and 4–5 inches in diameter. It is nearly cylindrical, and holds three-quarters of a gallon. At each discharge, by means of a counterpoise, it makes, or is intended to make, a complete revolution, returning to its original position, where it is held by a ratchet and catch. Should it fail to regain this position, the water from the sink pipe fills a small cup at the back of the tipper, shown in the section, and the weight of this water restores the tipper to its proper position. The flush from the tipper converging to the orifice cleanses the pan very effectually; but the tipper itself I found usually coated at the back with an offensive slimy layer of congealed greasy matter deposited from the dirty water which falls on it there during its revolutions.

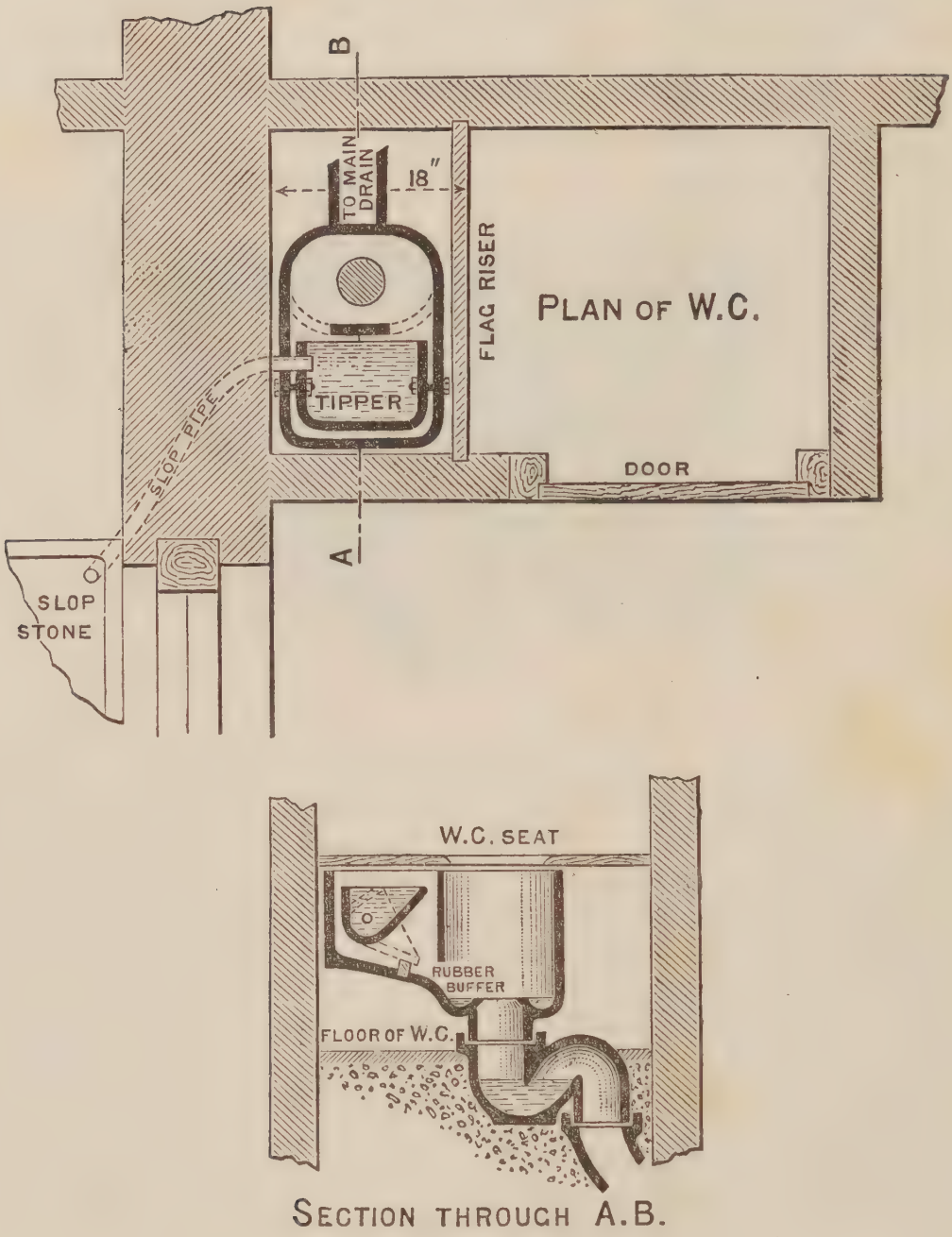
The pan is made of pedestal shape, the tipper being accessible by a hinged lid at the back; the closets are made right and left hand to suit the direction of the slop-stone pipe.

Another closet of this kind is the "Blackburn closet" of Messrs. Duckett and Son, Burnley, of which a plan and section are given on the next page (Fig. 17).

It much resembles the arrangement B of the same makers before mentioned, and is made in two sizes; the tipper is situated at the side, and holds three gallons in the larger size and one and a half gallons in the smaller size. I did not, however, see any of these closets in actual use.

Fig. 17.

Duckett's Blackburn Closet.




Section through A.B.

Advantages of automatic slop-closets over privies;

*Advantages and drawbacks.*—The advantages claimed for slop-closets are as follows:—

A. On the one hand that over midden-privies, pail-closets, or any other so-called "dry" system in use in towns, they have the following great advantages:—

1. The absence of the nuisance and danger to health arising from the retention, in greater or less quantities and for a longer or shorter time, of fœcal matter in the neighbourhood of houses.
2. The avoiding of the nuisance and expense of the removal of fœcal matter by hand.

Whatever may be the advantages of so-called "dry closets" in isolated houses or rural places, the advantages appear to me unquestionably to be altogether on the side of slop closets where sewers and water supply are available for the water carriage of excrement.

B. Over waterclosets of the usual kind on the other hand, it is claimed that slop-closets possess the following advantages :—

1. Less prime cost.
2. Economy of water; resulting in a saving to the public, where the supply of water to closets is furnished gratuitously; to occupiers or owners, where the supply of water to closets has to be paid for. over ordinary W.C.'s;
3. Diminution in the volume of sewage to be treated.
4. Non-liability to be affected by frost.
5. Less liability to get out of order through rough usage.

I will consider the latter points seriatim.

1. Prime cost.—The following are the present contract prices at Blackburn for providing and fitting closets of different kinds. (The contracts are made by tender, and are for 50 closets; the prices named are per closet, and are for providing and fixing the closet apparatus only, exclusive of erection or alteration of the privy building. The erection or alteration of the building costs less in the case of a slop-closet than of a watercloset, as the building need not be so high; the local regulations as to waterclosets requiring the flushing cistern to be fixed at a height of at least 4 ft. 6 in. above the closet basin.) in prime cost;

| | £ | s. | d. |
|---|---|---|---|
| W.C. fittings,* cistern, pan, &c., and fixing - | 2 | 2 | 0 |
| Duckett's A system (tipper by slop-stone) - | 2 | 2 | 0 |
| Duckett's B system (tipper by closet) - | 1 | 18 | 0 |
| Hindle's closet - - - - - | 1 | 15 | 0 |

At other places I was informed that the prime cost of a slop-water closet was about the same as, or rather less than, that of an ordinary watercloset.

2. Economy of water.—In Blackburn the following figures were given me by Mr. McCallum, borough engineer, as the result of experiments on the amount of water consumed in houses of a similar class with and without waterclosets :— cost of water;

| | | |
|---|---|---|
| Water used in houses with W.C.'s - | 13·62 | gallons per head per day. |
| ,, ,, without W.C.'s - | 9·05 | ,, |
| Difference due to use of W.C.'s† - | 4·57 | ,, |

Experiments as to the quantity of water used at houses with slop-closets were in progress at the time of my visit to Blackburn, and I am

* The specifications as to W.C. fittings are as follows,—The hopper basin and siphon trap shall be of glazed earthenware or stoneware, and of the best possible shape for preventing chokage and affording a good flush; the basin shall have an efficient flushing rim and inlet sufficiently large to admit the proper connexion of a $1\frac{1}{4}$-inch flushing pipe; the siphon trap to have a water seal of $1\frac{1}{2}$ inches.

The cistern shall be a perfect water waste preventer of wood lined with lead, and such as shall comply with the regulations of the Waterworks Committee. It shall give a good flush, and discharge not less than $2\frac{1}{2}$ gallons nor more than 3 gallons at each flush. The outlet for flushing pipe shall be $1\frac{1}{4}$ inches internal diameter. The flushing pipe from cistern to basin shall not be less than $1\frac{1}{4}$ inches internal diameter. The distance between the bottom of the cistern and the top of the basin shall not be less than 4 feet 6 inches.

† As illustrating the sufficiency of the slops for flushing it will be observed that the quantity of water used in houses without W.C.'s, and therefore passing away by the drains, was double the extra amount due to the use of a W.C. In addition to this amount the rainwater from the roof and yard surface is often carried through the closet.

since informed that they give an average consumption of 7·27 gallons per head per diem. The borough engineer accounts for the smallness of this quantity by the fact that the trials were made during a prolonged frost. He doubts, however, whether the saving of water effected will always be found to be so great as that above given, as the inspectors of the water department have reported that they have sometimes found water-taps left running with a view to flush the closets.

In Newcastle also it was said that people were apt to leave their taps running all night at houses where Fowler's closets were in use with a view to flushing them. This is obviously less likely to be done where closets are provided with an efficient flushing apparatus. At Burnley it was considered that a considerable saving of water was effected by the use of slop-water closets. The average daily supply of water in this town is 18 gallons per head, almost all of which is used for domestic and municipal purposes, water for manufacturing purposes being obtained from the canal.

Where a charge is made for the supply of water to waterclosets house-owners are led to adopt slop-closets with a view to escape this charge; but at York the waterworks company claimed the right to make the extra charge for a watercloset where a slop-closet was used, and the question was about to be tried in a court of law.

3. Diminution in the volume of sewage to be treated. This will of course be equal to the saving effected in the quantity of water supplied.

in being less apt to freeze,

4. Their less liability to be affected by frost seems to be a distinct advantage of slop-closets over ordinary waterclosets for out-of-door use. In such situations waterclosets are frequently put out of order during severe frosts by the freezing of the water in the cisterns, and the bursting of the supply pipes, unless more care be taken than is usually done to protect these by non-conducting material. In extreme cases even the water in the trap may be frozen. At Burnley I was told that during the three years since automatic slop-closets had come into use there had been no frost severe enough to interfere with their action, and I have since been informed that during the exceptionally severe and prolonged frost of the present winter (1890–91) not a single underground fixture—closet, tipper, or siphon tank—has frozen.

Trough-closet cisterns and supply pipes, on the other hand, have frozen extensively.

Similar information as to the non-freezing of slop-closets during the recent frost is given me from Blackburn and Bingley.

In slop-closets of the bottom-flushed kind the basin and trap are so far under ground as to be out of the reach of any degree of frost met with in this country. Also the waste water from a house is in winter more or less warm in comparison with the temperature outside, and will therefore take longer to freeze. Even should the water in the tipper freeze, no harm is likely to be done. The closets in which the basin and tipper are above ground would seem more exposed to the risk of freezing than the others, but I did not hear any complaint of this happening.

and get out of order.

5. On the whole, automatic slop-closets appear to have some advantage over waterclosets in being less likely to get out of order. The slop-flushing arrangement, by means of a well designed tipper, is less likely to be deranged by careless usage than the water-supply to a watercloset, and it gives a better flush. The chief difficulty in both kinds of closet is that of the trap being apt to be blocked by improper substances, sticks, rags, scrubbing brushes, dead cats, tins, cans, &c. thrown

into the basin by children or careless people. In practice this does not very often occur; in Bradford where about 30 Duckett's closets are in use (some of them for three years), and those not of the present improved pattern, both the manufacturer's agent, and the inspector of nuisances stated that they had never been called in to put right any of these closets which were out of order. At Burnley it was stated that the automatic slop-closets rarely got out of order, and then only through improper articles being thrown down, but at Blackburn it was considered that they were more liable to be choked in this way than an ordinary watercloset. Unless impacted in the trap, such foreign matters can be fished up with a long iron rod hooked at the end, but should the trap be choked so as to require opening, it is undoubtedly more difficult to get to in an underground slop-closet than in a watercloset.

Their disadvantages.

*Disadvantages.*—The drawbacks to automatic slop-closets appear to be as follows,—They are certainly less cleanly and less sightly than a good watercloset flushed with clean water, though they might be improved in this respect by making the shaft of white-glazed ware. There is apt to be some offensive smell from them, either from lodgment of excreta at the bottom (when unprovided with any mechanical arrangement for increasing the flush), from fouling of the surface of the shaft, or from effluvia from the closet following the slop-stone pipe into the house, where the connection is direct and untrapped. If badly fixed,—as were some that I saw, the shaft not being fairly under the hole in the seat, or not being brought up high enough,—filth may accumulate under the seat outside the shaft. These objections, however, apply to imperfect forms of slop-closet, and to those of bad workmanship, rather than to well-designed and well-fixed examples, which were at the time of my inquiry in November as free from offensiveness as need be wished. Whether this would hold good in hot weather I am not prepared to say, but even then I feel sure that such closets would compare favourably with midden or pail privies.

Circumstances under which they may be used.

*Application.*—The use of automatic slop-closets can only be recommended under the following conditions:—

1. That the closet be out of doors. The fact that the trap habitually contains dirty water renders it unsuitable for use indoors; and a closet in such a situation would involve too close a connection between the drains and the interior of the house.
2. That good sewers be available at a sufficient depth and with good fall.
3. That water be supplied by public service laid on to each house. I do not think it likely that slop-closets would act satisfactorily where water for domestic purposes had to be raised by hand, fetched from a distance, or bought by the pail full. In fact the manufacturers did not recommend them for use under such circumstances, nor did I hear of or see any so used. At Ilkley, however, a range of Duckett's closets was being fixed, to be flushed by one five-gallon tipper supplied with water from a brook.
4. It is also desirable (though this condition is not so essential as the preceding) that there should be a separate closet to each house, in order to secure the closet being taken care of and properly flushed.
5. I am of opinion that the advantages of a sudden flush are so great that the use of a tipper of adequate capacity, or other similar contrivance should be required, in any byelaws made under

s. 23 (1) of the Public Health Amendment Act, 1890, as a condition of the exemption of the owner of a slop-closet from the obligation to have a supply of water for flushing laid on.

The field of usefulness of slop-closets (circumscribed by the preceding conditions) is limited to towns and quasi-urban places. They are especially adapted for a class of people intermediate between the more fastidious, who will prefer indoor waterclosets, and the lowest and roughest, for whose use trough-closets or some other appliance must be provided which will stand rough usage, and which will not need personal attention on their part. Slop-closets are, in my opinion, likely to be of great use (both for new houses and in substitution for existing privies) in the growing working-class suburbs of towns, where each house stands in its own curtilage and has its separate closet; and especially where it is desirable to economize the public supply of water. In flat districts the difficulty of getting sufficient fall may be an obstacle to their use. In the old, closely and irregularly built slums of towns they are less likely to be found applicable, both on account of the difficulty of arranging them in suitable positions, and as less suited to the class of people inhabiting such localities.

## II.—Trough-Closets.

Trough-Closets.

Discharged by lifting plug in use at Liverpool.

Trough-closets are closets connected with a trough, usually common to two or more seats, which is partly filled with water into which the excreta fall, and are discharged with it from time to time. By an automatic trough-closet is meant one in which the excreta are removed by the automatic discharge of a volume of clean water let into the tank at its upper end.

Trough-closets were found by Dr. Buchanan and Mr. Netten Radcliffe in extensive use in Liverpool in 1869, and are spoken of in their report as admirable in arrangement and working. These closets are figured by Mr. Radcliffe in his report of 1874, who states that the five years' additional experience had confirmed the opinion as to their adaptability to the wants of a poor population.

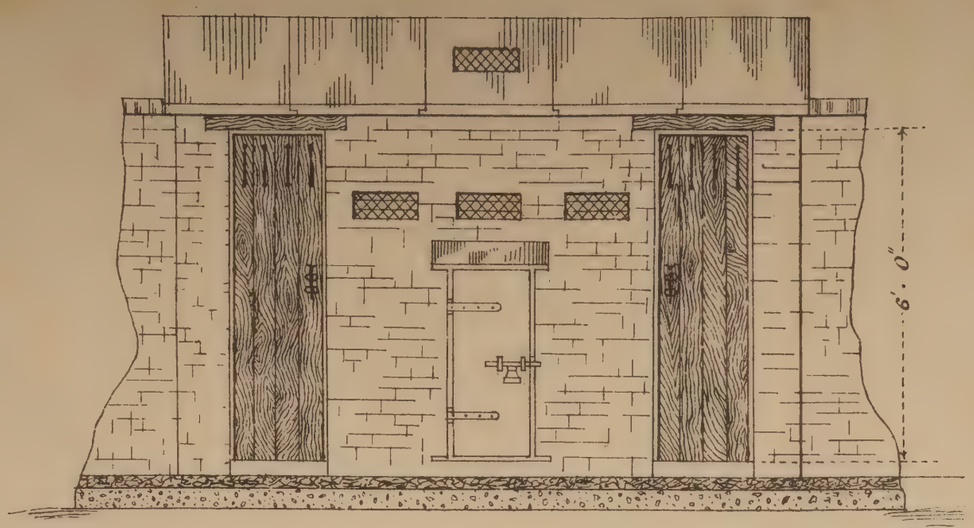
There are at the present time about 3,000 trough-closets in use in Liverpool, serving for about 18,000 houses, and 90,000 persons, but their number is being gradually diminished by the demolition of court property. (Thus 41 courts were reported by the medical officer of health for demolition in 1889, each of which would contain on an average six houses and one double trough-closet; and about as many are demolished year by year). The trough-closets are only in use in common courts; and as all the old privies have been done away with, and all new houses are required to have a separate backyard and water-closet, no new trough-closets have been erected since 1876, except at works, common lodging-houses, &c.

The trough-closets are still found to work satisfactorily under the conditions described by Mr. Netten Radcliffe in 1874, of daily attention by the servants of the Corporation. Dr. Stopford Taylor, medical officer of health for Liverpool, considers that there is no other system equal to them for the inhabitants of courts, where more than one family have the use of a closet, in common lodging-houses, and in factories and workshops where many people are employed. The troughs as a rule serve for one or two closets only; but I saw one range of three closets. (See Figure 18.) At one end of the trough if single, or in the centre where there are two or more, is a locked compartment, containing a

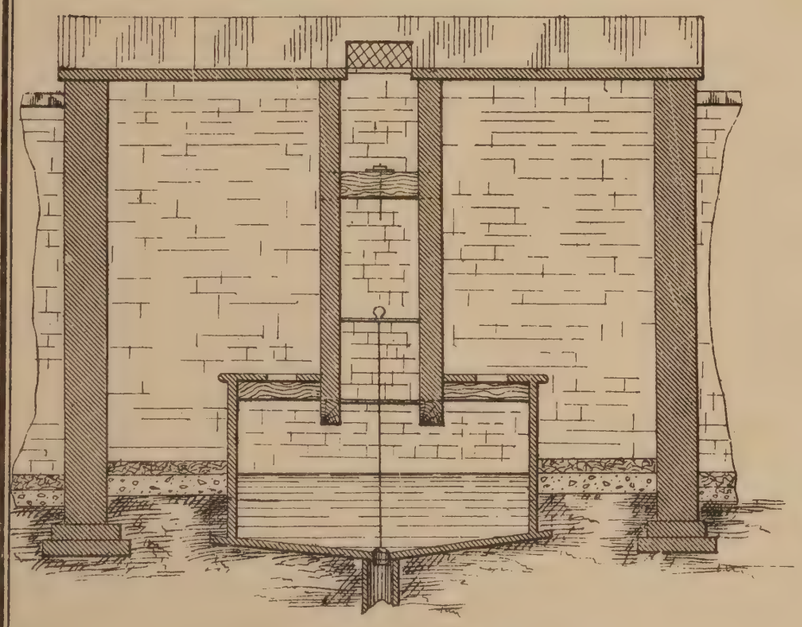
# FIG. 18.

## DOUBLE TROUGH WATER CLOSET

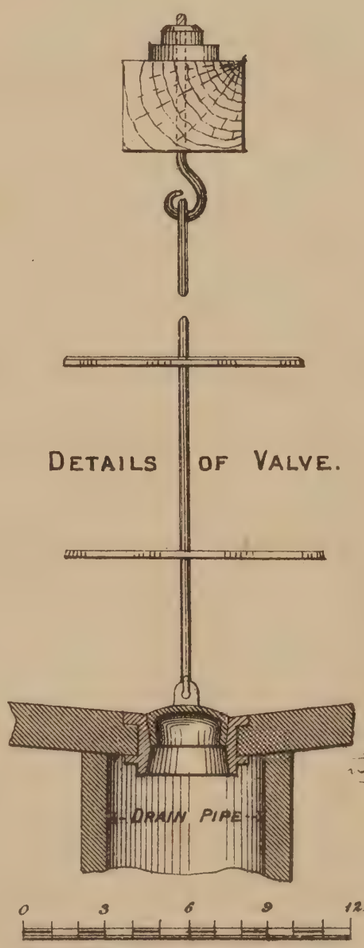
## LIVERPOOL.



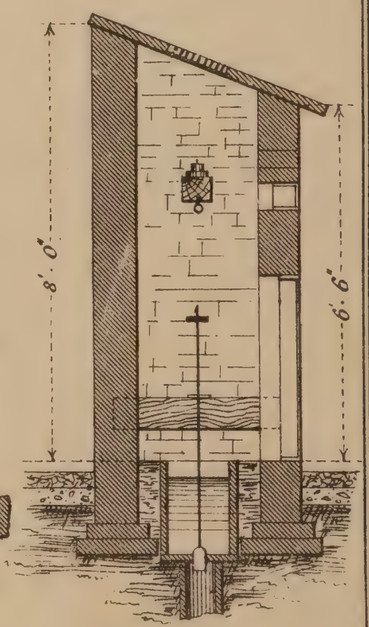

FRONT ELEVATION.



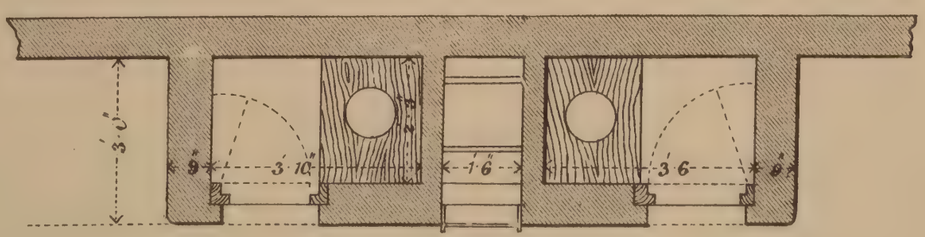
LONGITUDINAL SECTION




DETAILS OF VALVE.

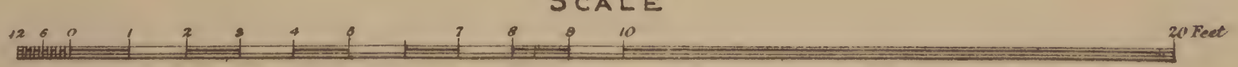



CROSS SECTION.




PLAN.

SCALE




*City Engineer's Office, Nov.r 1880.*

CLEMENT DUNSCOMBE, C.E.

Judd & Co Lith. 73 & 75. Farringdon Rd & Doctors' Commons. 1882. 4. 91

plug and a water-tap. This compartment is accessible only to the scavenger, who, on his visit, which is made once or in some cases twice daily, empties the trough, cleanses it with water and brush, and charges it with fresh water. One man can attend to about 60 troughs in a day, working from 5 a.m. to 4 p.m. The cleansing of the seats, floor, &c. of the closet is not done by the Corporation, but is enforced in rotation upon the families using it. The troughs are usually made of slate, sometimes of stoneware. The cost of a trough-closet with two seats is stated to be about 10*l*.

In the severe frost of January 1891 some inconvenience was experienced from the freezing up of the supply pipes, which necessitated the carrying of water to flush the troughs, but otherwise the trough-closets were much less affected by the frost than ordinary waterclosets.

At my visit to Liverpool I saw a number of trough-closets in some of the worst courts of the city. With the exception of one which was stopped up so that the plug could not be put in place, the closets were in good order and free from offensiveness so far as the troughs were concerned; but of many of those used by a rough class of people the seats were very filthy. There was also in some cases an accumulation of dried excrement on the back of the trough above the water-level.

I saw, however, a range of trough-closets at a common lodging-house which was attended to by an employé and not by the Corporation men, which was not at all satisfactory. It was supplied with water by the waste water from the lavatory, and the interior of the trough, which could not be got at to be brushed out, was smeared with slimy filth, and very offensive when the trough was emptied.

[The older waterclosets which I saw in Liverpool were of the "long hopper" kind; the flush of water, which came usually through a narrow, much-bent pipe, was weak and ill-directed; and the pans were generally in a foul state. The newer out-of-door waterclosets, on the other hand, are of the "short hopper" pattern and have a good flush, and these were generally found in good condition.]

Leeds.

A trough system similar to that at Liverpool exists at Leeds. The closets are in ranges of three or four, with a central compartment containing the plug by which the trough is emptied, and a tap by which it is filled with water. Each closet is visited every night by a man in the employ of the Corporation, who lets off the contents of the trough, brushes it out, and fills it again with water. One man can visit about 40 ranges of closets in a night, but the number which can be attended to varies according to whether the trough-closets are near together or are scattered here and there in streets chiefly provided with midden privies. The re-filling the trough with water occupies some time; and if closets are near together the man can be emptying and cleansing one trough while another is filling, whereas if the next trough-closet is at a distance he has to wait until the first is filled with water before leaving.

Macfarlane's.

Another kind of trough-closet is Macfarlane's. This consists of an iron trough, over which the seats are fixed. In a box at one end there is a plug lifted by pulling up a lever, and a ball-tap by which the trough is filled up to a certain level with water. This arrangement, as I have seen it at schools, unless more carefully attended to than often is the case, is horribly offensive. The rough interior of the cast-iron trough gets coated with an offensive slime, and it is never flushed clean, for as the depth of water in the trough diminishes during the act of emptying, its force, owing to friction against the bottom and sides, gets less and less, and the last dribble is quite unable to carry away the adhering

sediment, in the absence of a head of water from behind. The seats also are some times so arranged that it is difficult to get a broom into the trough to sweep it out. A trough-closet of this kind, if not emptied for several days, is much the same thing as regards offensiveness as a pail-closet into which liquid is thrown, with the additional drawback that the trough being common to several closets, infectious matter passing into any one closet infects the whole of the range. A further source of danger in these closets is the ball-tap. If this be connected directly with the water service, there would be a risk of foul air from the trough being drawn into the water-pipes, should an intermission in the water-pressure occur at a time when the trough was empty and the ball-tap open.

The one condition of success of trough-closets discharged by hand is daily attention by a responsible person appointed by the sanitary authority, or as at mills and schools, by the proprietors or managers. Given this, as at Liverpool and Leeds, the system seems to answer well, and to be adapted for the use of the lowest class of the population. Articles improperly thrown in can be readily removed, and the risk of infection of the whole range by the excreta, say, of a case of enteric fever, being thrown into one compartment is now obviated at Leeds by using in such cases a special pail painted red to receive the dejecta of the patient instead of throwing them into the closet; this pail is separately removed daily and its contents disinfected.

Trough-closets flushed from above:

by hand

In another class of trough-closets the outlet of the trough is always open, the drain from it being trapped (which is not necessary where a plug is used), and a certain depth of water is retained in the trough by the bottom being raised in the neighbourhood of the outlet so as to form a weir. The contents of the trough are washed out from time to time by the sudden forcible discharge of a quantity of water from a tank above the upper end of the trough.

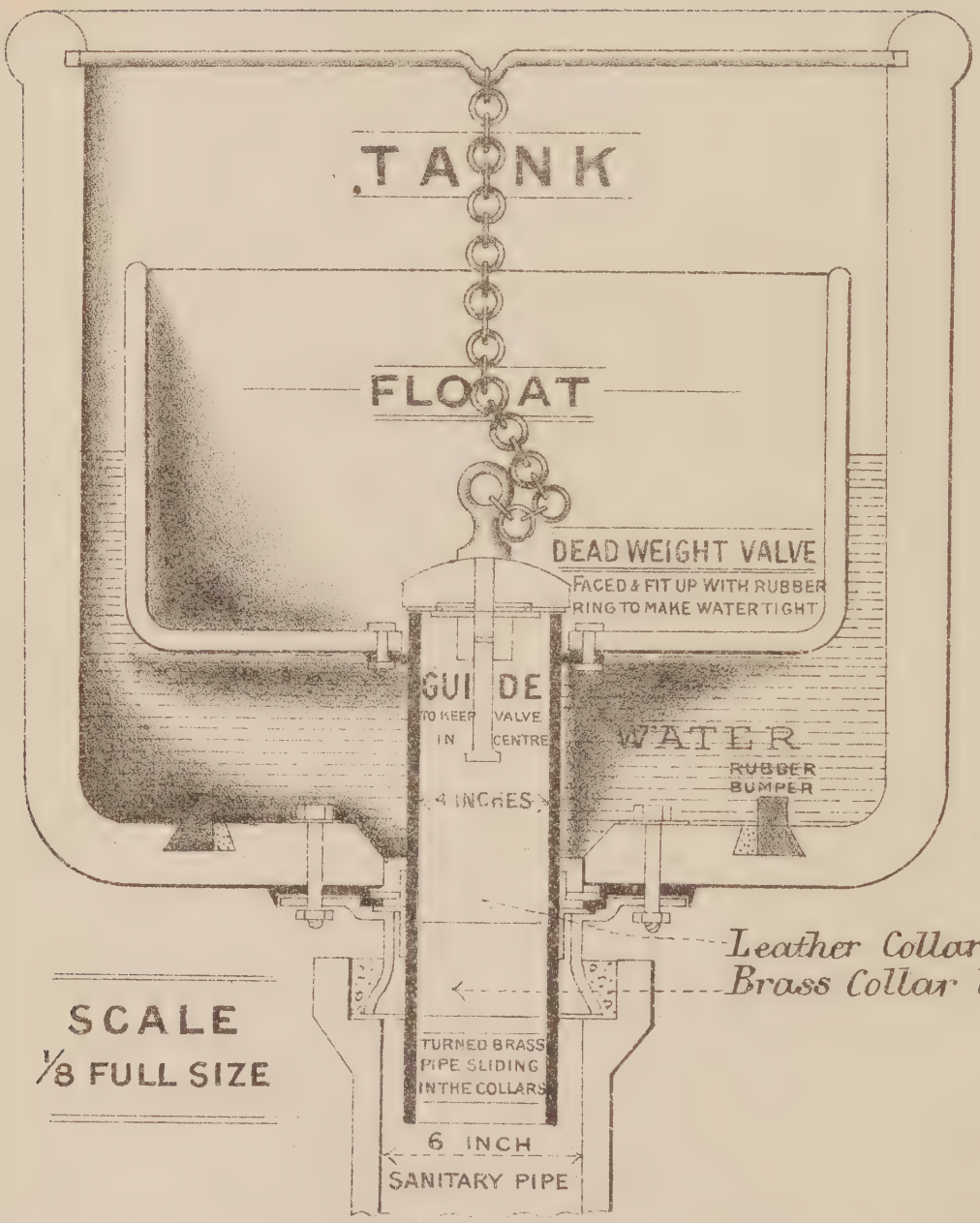
All the automatic trough-closets with which I am acquainted are on this principle, but there are trough-closets on this principle which are not automatic, but require the contents of the tank to be discharged from time to time by pulling a valve. At Burnley such closets are discharged two, three, or four times a week according to the state of the weather by men in the employ of the Corporation. The reason for preferring this method of flushing to an automatic one is stated to be that less water is used, it being difficult to arrange an automatic flushing tank to discharge at such long intervals. In quarters, too, inhabited by a low-class and dirty population, there is an advantage in the closets having to be frequently visited by the servants of the Corporation, in securing the seats being kept clean, and removing from the trough bodies which might stop up the drains. I think, however, that a daily flushing at least should be undertaken.

Tumbler closets.

"Tumbler-closets," like those described in Mr. Netten Radcliffe's report, come under the category of "automatic trough-closets," the tumbler or tipper, of larger size than that used in slop-closets, being filled with clean water from a tap. There are several ranges of such closets in Leeds containing in all 49 closets. I saw four of these ranges, including the one in Henry Street figured in Mr. Radcliffe's report (Plate XXIX.).

Of this range the invert is of earthenware, semicircular and broad enough to serve two rows of closets back to back. Of the others the trough was of brickwork faced with cement, and only wide enough for a single row of closets. The depth of the trough was in some cases

*To face p. 183.*




## DUCKETTS' PATENT AUTOMATIC FLUSH TANK.

Judd & Co Lith. 1882 4·91

very great; the sides were smeared thickly with excrement, and the cement had peeled off, leaving the rough brickwork bare. Of the tumblers, two, viz., that in Henry Street and another, worked with so much friction, owing apparently to the rusting of the iron pivots, that they did not return to the horizontal position after discharging; in both these cases there was a lodgment of excrement in the bottom of the trough; and in the former also the water from the tap was percolating through a brick wall and flooding the cellar of the house under which the tumbler was placed. The tumbler in some cases was so placed that much of the force of its discharge was wasted by the water dashing against an opposing wall. One range of nine closets, however, was in fair working order. All appeared to use a considerable quantity of water.

As none of these closets have been erected in Leeds during the past 20 years, the system can hardly be said to be of interest at the present time from other than an antiquarian point of view; but I see no reason why it should not answer well if proper attention were given to the details of construction.

Automatic trough-closets.

The more usual automatic flushing arrangement, however, is a tank holding 40 or 50 gallons placed above the upper end of the range of trough-closets, and discharged from time to time by a siphon. The siphon is usually formed of two concentric pipes, the lip of the inner tube overhanging into the interior so that the water overflowing drop by drop expels successive portions of air until a vacuum is created sufficient to start the siphon. This arrangement acts well with clean water, though it is liable to get out of order when used with sewage. Messrs. Duckett and Son sometimes use a small tipper, into which the water flows, and the sudden discharge of which starts the siphon.

In the automatic flushing cistern patented by the Burmantofts Company, Leeds, a floating ball rises until it overbalances a weight; this weight falling opens a valve, and allows a stream of water to enter the long leg of the siphon, which starts its action. As the cistern empties, the floating ball sinks and closes the valve before the level of the water has got low enough to allow air to enter by it.

An automatic flushing tank (shown in Fig. 19) recently patented by Messrs. Duckett and Son, in which the siphon is dispensed with, has the advantages of giving an exceptionally strong flush, and of starting suddenly even with a drop by drop supply of water. The tank, which holds 40 gallons, is of earthenware, 24 inches in diameter and 24 inches deep, and it contains a floating cistern 22 inches in diameter and 11 inches deep; the outlet is at the bottom of this floating cistern and is connected with a turned brass pipe 4 inches in diameter, which slides watertight through a leathern collar at the bottom of the outer tank and discharges into a 6-inch outlet pipe below. The outlet from the floating cistern is fitted with a weighted valve resting upon an india-rubber seating, but this valve is suspended by a chain from a cross-bar fixed across the top of the outer tank; the chain being of such a length that when the floating cistern is at rest at the bottom of the tank the valve is held up about 4 inches above the outlet, which is thus freely open. The water is delivered into the narrow space between the inner and outer cisterns, and as its level rises, it lifts the floating cistern until it reaches the suspended weight and the outlet valve is thus closed. The floating cistern continues to rise until arrested by the cross-bar at the top; the rising water then overflows into the floating cistern, which when nearly full sinks by its own weight to the bottom of the tank, and the valve being stopped by the chain when 4 inches from the bottom, the outlet is opened, and the water is discharged with great force.

App. A. No. 20.

On Slop-Closets and Trough-Closets; by Dr. Parsons.

It is found necessary that the tank of an automatic trough closet should be placed in such a position that it cannot readily be got at or tampered with. It should be protected against frost, and so also should be the feed pipe.

In automatic trough closets the flushing pipe, of iron or earthenware, is six inches in diameter: the trough is of stoneware or iron,* sloped at the back to avoid fouling; the outlet is sometimes furnished with a coarse grid to prevent matters improperly thrown into the trough from being washed into the drain.

The illustration given in Fig. 20 is the trough latrine of Messrs. Bowes Scott and Read of Westminster, fitted with Rogers Field's patent (1889) annular siphon.

Trough-closets of this description are also made by Messrs. Adams of York, Doulton of Lambeth, and Duckett of Burnley, and by the Burmantofts Company, Leeds. These are all very similar, and I am not able to give a preference to one over the other. All that I have seen act very well. The contents of the tank are discharged in a powerful stream which carries away all excrement, thoroughly cleanses the trough, and leaves it charged with clean water.†

Advantages.

A range may contain eight closets, and longer ranges are sometimes fixed, but are not recommended.

Automatic trough-closets appear to be little liable to get out of order. Some (Adams's) which I saw in Kidderminster five years ago are stated to be still working well. They are also little liable to be damaged by rough usage; the chief danger is that of improper matters being thrown into them. A good drain, of ample size and well jointed with cement, is necessary.

Drawbacks:

The drawbacks to automatic trough closets appear to be—

1st. They are somewhat expensive in first cost.

2nd. They consume a good deal of water.

3rd. Complaints are sometimes made of the alarming noise and objectionable splashing if the cistern happens to be discharged while the seat is occupied.

The first cost is lessened in proportion per seat where a number of closets can be placed side by side. At Burnley a set of five trough closets, including buildings, can be erected for about 18*l.* or 3*l.* 12*s.* each.

quantity of water used.

The chief objection raised to them, however, was the quantity of water required.

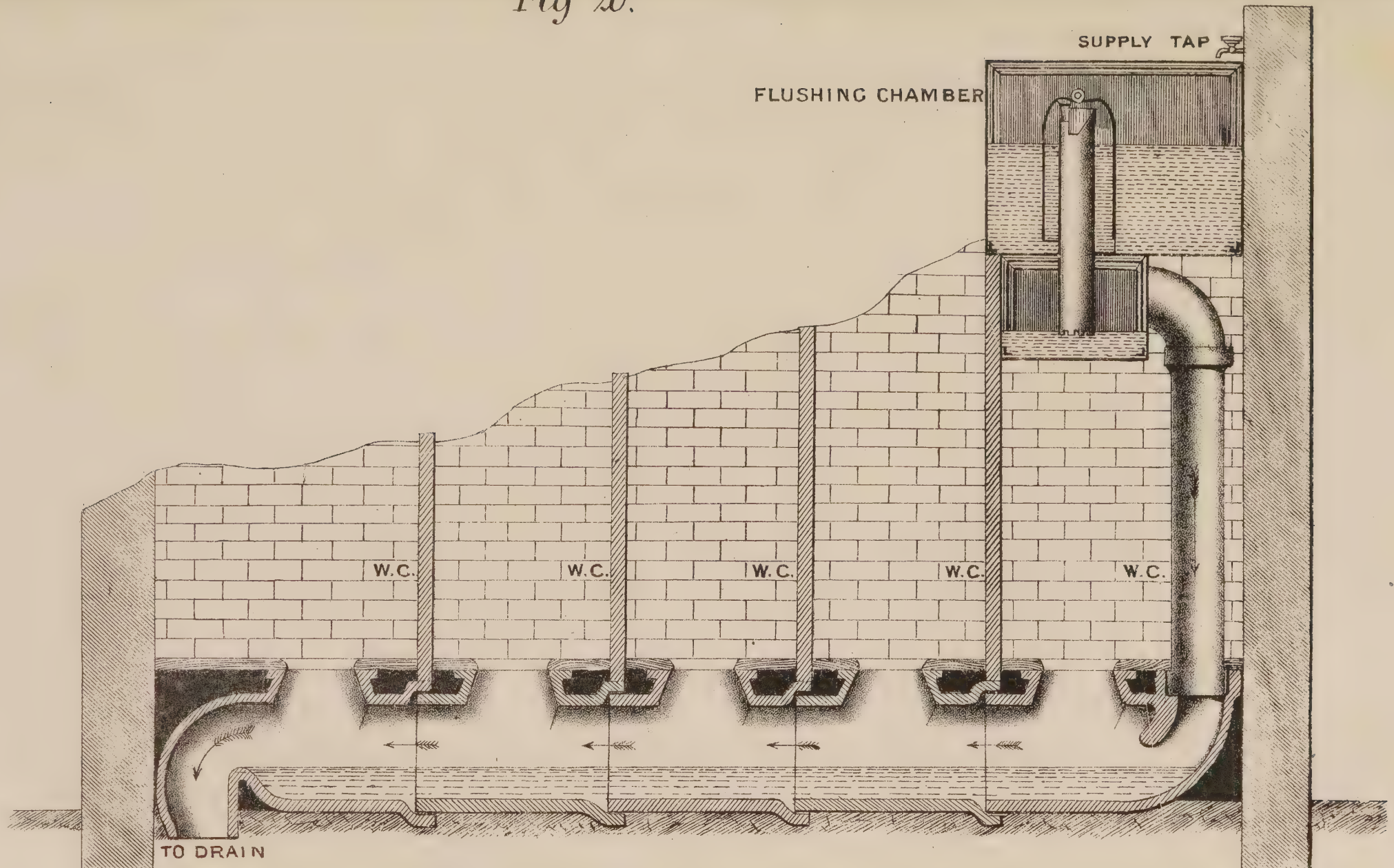
At Bingley a range of eight Adams's trough-closets, flushed by a 50-gallon cistern, was found to consume 160 gallons of water per diem.

At Burnley, as before mentioned, tanks discharged by hand two, three, or four times a week were preferred to those discharged automatically, as consuming less water. It was stated that a tap could not be set to run so slowly as to fill a 50-gallon tank only once in 24 hours, as an orifice so small would soon get clogged up altogether. At both Burnley and Bingley the public water-supply is a moorland water unfiltered, and it is probable that the clogging up of the tap may be due to minute fragments of moss and heather. At Swinton, where the water is filtered,

* Stoneware is cheaper and more cleanly than iron, but the latter may be preferable where very rough usage has to be guarded against.

† At two potteries at Hanley I saw trough-closets of this class in which there was a considerable accumulation of fæces, but in these instances the supply of water (which is purchased by meter) had, from motives of economy, been turned off for some days.

*Fig 20.*




SECTION OF EARTHENWARE LATRINE
(BOWES SCOTT AND READ'S.)

Judd & Co Lith. 73 & 75, Farringdon Rd & Doctors' Commons. 1882, 1, 91

*To face p. 184.*

this difficulty has not been found.* Here a tank, holding 40 gallons, flushing three closets, is made to discharge about three times a day, *i.e.*, consuming 40 gallons a day per closet.

Three discharges a day are the maximum frequency aimed at at Kidderminster. As a minimum I think that a discharge should take place at least once in every 24 hours, and the third objection above noted might be met if it could be arranged that this discharge should take place at night.

Let us take the case of a court containing 16 houses, and provided with a range of eight trough-closets—one to two houses, a not unusual provision in old property—flushed by a 50-gallon tank, discharged three times a day. This would give a consumption of water of 150 gallons daily, less than 10 gallons per house, or, taking five inmates per house on the average, less than two gallons per head. This consumption is over and above what would be required if midden or pail privies, or slop-closets were in use, but it is less probably than would be required by ordinary waterclosets. At 10*d.* per 1,000 gallons, the water would cost $1\frac{1}{2}d.$ daily, or 2*l.* 14*s.* a year for the 16 houses, a sum less than the effectual scavenging of pail-closets would cost, and which the sanitary advantages of the trough-closets over the midden privy would be quite worth.

Circumstances in which useful.

*Application.*—Automatic trough-closets can only be used where good drains and means of sewage disposal exist, and where a supply of water is laid on.

Their field of usefulness is for places where many closets stand in a row, as at mills, schools, and other establishments where many people are employed; and also in courts and old property where a rough class of tenants exist, and where one closet may have to serve for two or more houses. In such places automatic trough-closets may conveniently replace the old ranges of midden privies, and for such places trough-closets are, in my opinion, from a sanitary point of view by far the most suitable appliance.†

Whether automatic or hand-flushed trough-closets should be used, would seem to depend mainly upon whether it is cheaper to use more water, or to pay a man to look after them.

### *Some General Considerations on the System of Removal of Excrement by Water as applied to the Poorer Classes of the Population.*

Water carriage versus dry systems of excrement removal.

The difficulties attaching to the watercloset system, as applied for the lowest classes of the population, were thus summarised by Dr. Buchanan and Mr. Netten Radcliffe in their report in 1869:—

Objections to W.C. system;

"A fragile pan, professing to be trapped, but with the trap almost certainly blocked up or knocked to pieces by the implement that has been used to get rid of obstruction; supplied, if in good order, with water by trickling from a small tap, but the tap usually either fixed or leaking wastefully all day long; no water in time of frost; almost universally filthy and stinking, and washed out (in a fashion to render the place unusable for hours) only every few days when the sanitary inspector is discovered to be in the neighbourhood."

Some of the above difficulties are such as attach to the use of any kind of closet by the roughest class of people, especially where

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* A special drip-tap with strainer is made by Adams & Co. to meet this difficulty.

† Of course ash tubs or bins have to be provided for the reception of ashes and dry refuse, but the scavenging of these, if free from fæcal matter and kept dry, is a comparatively simple and inoffensive business.

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On Slop-Closets and Trough-Closets; by Dr. Parsons.

one closet has to serve for several different families, and it must be admitted that under such circumstances neither waterclosets nor slop-closets answer well for long without supervision.

lessened since 1869.

Much, however, has been done since 1869 to improve the water-closet. The old-fashioned pan-closet with its stinking "container" and D trap, and the "long hopper" with its weak spiral flush have been largely superseded by better forms; and water is now laid on to the closet, not by a tap or valve direct from the service pipe—an arrangement which, besides being inefficient and wasteful, involved under some circumstances a risk of foul matters being drawn back into the water-pipes—but from a service cistern (preferably of the siphon kind) which discharges at each use two or three gallons of water in a powerful and well applied flush.

The system of ventilation of drains by two openings for inlet and outlet, as required by the model byelaws of the Local Government Board, and now enforced for new houses in a large number of districts, has also done much to diminish the dangers to health attaching to the use of indoor waterclosets.

Together with improvements in the construction of waterclosets, and the more usual requirement—in new property at least—of a separate closet for each house, there has been at work a process of popular education, so that by the decent working class the use of waterclosets is better understood than formerly, and the advantages of cleanliness are better appreciated.

Difficulties of "dry" systems.

In the towns visited by me, the "dry" systems of excrement removal, besides their offensiveness, have not only not realised the hopes of profit which were at one time entertained, but have proved in practice very expensive in working, while on the other hand the works of water-supply, sewerage, and sewage disposal, which have of late years been carried out, have afforded increased facilities for the extension of the system of water carriage.

increased.

Again, owing to the growth of population in the larger towns and the depression of agriculture, the demand for night soil, relatively to the supply, has lessened;* while in many places ashes and dry refuse are found so difficult to dispose of, that they are got rid of by burning them in "destructor" furnaces, a process which the presence of excrement renders more difficult. These circumstances have tended to render it desirable, even from an economic point of view, to separate the excrement from the solid refuse of a town, while the sanitary advantages of its rapid removal have become more generally recognised.

Progress has been in favour of water carriage system.

For these reasons, since the issue of Mr. Netten Radcliffe's report in 1874, the tendency, in towns visited by me at least, has been more and more in favour of the water carriage of excreta, while the "dry" systems have come more and more into disfavour.

At Manchester, where the pail system has been considered to have been very successfully worked at an annual cost of 9*s.* 9*d.* per closet, the excrement collected being converted into a dry guano, selling at 3*l.* a ton, the Health Committee have recently suggested the discontinuance of the pail system, and the Unhealthy Dwellings Committee, after examining the systems in use at Leeds

* Another reason for the lessened demand for town manure by farmers, is the large admixture which it is found to contain of tin cans and other similar matters worthless as manure, owing to the increasing use of tinned meat and other preserved provisions.

and Burnley, have unhesitatingly recommended that in view of the sewage scheme now being pushed forward, the water-carriage system should be adopted as far as practicable in the future, and that the Town Council should seek such powers as will enable its uniform introduction to be insisted on.

The two classes of inventions now reported on seem to me to offer facilities for the more general adoption of the water-carriage system among the masses of our urban populations; the slop-closet with automatic flushing being well adapted for use at the artizan's cottage, with its separate closet standing in a private yard; the trough-closet, automatic or otherwise, being adapted for use in common courts occupied by the lowest and roughest section of the community, and also at schools, mills, and other places where closets are used in common by large numbers of people.

*Summary.*

Summary.

1. By a "slop-closet" is meant one in which the excrement is washed away down the drain by the waste liquid of the household, instead of by clean water supplied for that purpose.

2. Given good drains, and a supply of water laid on in pipes, the volume of waste liquid produced in a house is sufficient to carry away the excrement of the household, if led by a drain into a closet of appropriate design.

3. The removal of the excrement is better accomplished if the waste water, instead of being allowed to run away as produced, is intercepted by a mechanical arrangement, and discharged through the closet from time to time in a considerable volume. Such an arrangement is here called an "automatic slop-closet."

4. The mechanical arrangements which have been used for this purpose are the "tipper" or tilting tank, and the siphon tank. Of these the tipper is to be preferred for use with slop-water, as more certain and sudden in its action, and less likely to get out of order.

5. Automatic slop-closets are of two sorts, first, *bottom flushed* in which the tipper, drain, and basin are underground, and secondly, *top flushed* in which the tipper and basin are immediately under the closet seat.

6. In the first class the tipper, which should hold not less than three gallons, may be placed either next to the closet, or at the upper end of the drain, as may be most convenient; the shaft should be so constructed as not to be soiled by falling excrement; the basin should be of such a shape as to be readily flushed clean; and the trap should be of as small a capacity as practicable.

Two closets of this class may be connected together, but in this case the tipper should hold not less than five gallons.

7. Closets of the second class are applicable where there is not fall enough for one of the first class; the tipper should be of adequate capacity, and the basin of such a shape as to be flushed clean. The pipe connecting the slop-stone with the closet should be trapped, and, if practicable, should have in its course a section open to the air.

8. Automatic slop-closets should be used only out of doors, and are applicable only where sewers and a public water-service are available.

9. Their advantages over midden or pail privies are the avoidance of the storage of excrement in the neighbourhood of houses, and of the annoyance and expense of its removal by hand.

Over ordinary waterclosets the advantages claimed for them are—

Less prime cost.

Saving of water.

Diminution of volume of sewage.

They are unaffected by frost.

They are less likely than waterclosets to get out of order, at any rate as regards the supply of water to them.

10. Their drawbacks are that they are less cleanly than a good water-closet, and are liable to be blocked up by improper articles carelessly thrown down them.

11. They may be recommended for the use of a class of persons, such as artizans, above the lowest, but who do not require indoor water-closets. They will be found especially useful in the newer parts and working-class suburbs of towns where each cottage has a separate yard and closet.

13. Trough-closets are closets connected with a trough containing water, and common to two or more seats, and of which the contents are discharged from time to time, either (1st) by pulling up a plug at the lower end, or (2nd) by washing them out by a stream of water from above.

14. Trough-closets of the first kind require the daily attention of a specially appointed person to let off the contents, brush out the trough, and fill it with water. If not thus attended to they become extremely offensive. The use of a ball-tap for filling the trough is objectionable, as endangering contamination of the water-service.

15. Trough-closets of the second kind may be flushed either by a valve opened by hand, or automatically by means of a siphon tank, or other contrivance. They should be flushed at least once daily. For intrinsic cleanliness this form of trough closet is preferable to the first, but in places occupied by a rough and dirty class of inhabitants there is an advantage in the daily visit of an official to secure cleanliness.

16. The chief objection to automatic trough-closets is the somewhat large quantity of water which they consume, but it is doubtful if this need be larger per head than that consumed by ordinary waterclosets.

17. Trough-closets, automatic or otherwise, can only be used where good drains exist, and a supply of water is laid on.

Trough-closets are suitable for places where many closets stand in a row, and where closets are used indiscriminately by many people, as at mills and schools, and to replace ranges of privies in old courts. Of appliances for the removal of excreta by water they are, under due supervision, the most suitable for the lowest and roughest class of the population.

## No. 21.



Summary Review of "Food-poisoning Occurrences;" by Dr. Ballard, F.R.S.

A Summary Review of 14 Instances Reported upon since 1879 by the Board's Medical Inspectors or Communicated to the Board by Medical Officers of Health or others, in which Disease of a Specific Character has been communicated or spread by the use of Infected Articles of Flesh Food (cases of so-called "Food-poisoning"); by Dr. Ballard, F.R.S.

It has been thought that it would probably be useful to bring together the above 14 instances of so-called "food-poisoning" out of a rather larger number to be found among the records of the Department (the rejected instances being such only as were not communicated sufficiently in detail), and to endeavour to gather from them such general instruction as, thus considered together, they may be able to furnish. The following are the instances with which it is proposed thus to deal:—

1. In 1880.—The Welbeck epidemic. (Report of Medical Officer for 1880.)
2. In 1881.—The Nottingham series of cases due to the eating of baked pork. (Report of Medical Officer for 1880.)
3. In 1881.—A case of sausage poisoning near Chester.
4. In 1882.—An instance of poisoning from tinned pig's tongues at Oldham. Communicated to the Department by the Medical Officer of Health, Dr. Sutton.
5. In 1882.—An instance of family poisoning by roast beef at Bishop Stortford. Communicated to the Board by the Medical Officer of Health, Dr. Turner.
6. In 1882.—An instance of poisoning of several families at Whitchurch (Salop) by brawn. Communicated to the Board by the Medical Officer of Health, Dr. Thursfield.
7. In 1878.—An instance of family poisoning by roast pork, again at Whitchurch. Communicated to the Board by the Medical Officer of Health, Dr. Thursfield.
8. In 1884.—An instance of family poisoning by tinned salmon at Wolverhampton.
9. In 1886.—Poisoning by articles consumed at a wedding breakfast at Carlisle. Investigated and communicated to the Department by Dr. H. Barnes, of Carlisle.
10. In 1886.—Instance of family poisoning by veal pie at Iron Bridge. Communicated to the Board by the Medical Officer of Health, Dr. Thursfield.
11. In 1887.—Poisoning by pork pie or brawn at Retford. (Report of Medical Officer for 1887.)
12. In 1889.—Poisoning by pork pies and boiled pork at Carlisle. (Report of the Medical Officer for 1889.)
13. In 1891.—An instance of poisoning by meat pie at Portsmouth. (Recorded in this Report, p. 249.)
14. In 1888.—The epidemic of pleuro-pneumonic fever at Middlesbrough. (Report of Medical Officer for 1888.)

I shall furnish here but a précis of these instances, selecting only such of their details as can just now be made available. The full details of six of them are published in the Board's reports.

In all but the last instance the phenomena of illness induced by eating the implicated food were specially characterised by gastro-enteric disturbance. In the last instance the most marked and characteristic local phenomenon was pleuro-pneumonia, which has not hitherto been regarded

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as likely to be referable to the use of poisonous food. The term "food poisoning," as heretofore used, has been applied only to such cases as the greater number of the above instances illustrate. Outbreaks of food-poisoning (the gastro-enteric cases), whatever the special kind of food that produced the disease may have been, present certain features more or less in common. All are characterised by nearly simultaneous attack of a large proportion of the persons known to have partaken of the implicated food. And further there occurs a family likeness in them, both in the clinical features of the illnesses and in the pathological conditions of the organs of the body as found after death in the human subject, and in animals to which the disease has been communicated by feeding or by inoculation. It may suffice for my present purpose thus to describe the general features of a disease which may be in all instances absolutely the same, or which may possess varieties or sub-species corresponding to differences in essential cause. What is commonly met with clinically is this :—A person, at a varying period after eating the poisonous food, often and indeed usually without any preliminary warning (perhaps while he is engaged in his usual avocations, thinking himself quite well), is suddenly attacked by the initial symptoms, which may be rigors or one or other of the following symptoms: faintness, muscular weakness, and prostration, sometimes very severe, or giddiness, abdominal pains, vomiting, and diarrhœa, followed by fever, intense thirst, and more or less violent headache, and pains in various parts, and a variety of other nervous disturbances such as muscular twitchings, various disturbances of vision, dilatation of the pupil, or drowsiness; perhaps, at some period there is an eruption of the skin, and later on suppression of urine. Convalescence is apt to be prolonged and is sometimes accompanied by some desquamation of the cuticle. The pathological conditions noticeable after death in men and animals consist of inflammatory, hæmorrhagic or destructive changes in the stomach and intestines, pneumonic engorgement or a hæmorrhagic condition of the lung tissue, and inflammatory or destructive changes in the liver and kidneys. These are phenomena not of mere local irritation, but of a general disease. Both clinically and pathologically, therefore, the phenomena resemble those of our better-understood specific fevers with which this form of malady must in future be classed. The relation of the Middlesbrough epidemic to these same specific fevers has already been pointed out in my report on that outbreak.

1. *The Welbeck Epidemic.*—In 1880 I was instructed to investigate an extensive series of cases of diarrhœal disease which occurred among a crowd of some 2,000 persons who attended a sale at the late Duke of Portland's estate at Welbeck in Nottinghamshire. Some of those attacked died. The illnesses were traced to the consumption of certain cold boiled hams provided by an innkeeper for the refreshment of the visitors. In these hams (known in this country as "American hams" because made here from salted pork imported from America) and in the kidneys of a man who died Dr. Klein discovered a hitherto undescribed bacillus which produced general disease in animals into which it was inoculated, and mostly killed them, the organs after death being found morbidly affected as described above, the bacillus being also recoverable from their carcases.

2. *The Nottingham Case.*—In the following year it fell to my lot to investigate a similar series of cases in the town of Nottingham among persons of several distinct families who had partaken of a recently baked and hot leg of pork. One of these persons died, and the same bacillus as was found in the Welbeck hams was after death found by Dr. Klein in his blood, lung juice, pericardial fluid, kidneys, and other organs.

Inoculated into animals it produced results similar to those induced by the bacillus found in the Welbeck hams. The two instances were complementary the one to the other. In the one the infected food fed and inoculated into animals produced the disease, the bacillus being found in the dead animals; and in the other (when none of the food eaten was obtainable) the same bacillus was found in the blood of a man dead of the disease, and a pure cultivation of the bacillus inoculated into animals produced the same result.

3. *The Chester Case.*—Shortly after this I was instructed to investigate the circumstances of a death near Chester of a man, who about half an hour after eating some so-called "American sausage" (a material which arrived packed in a tin and consisted partly of pork), was seized with very violent gastro-enteric symptoms and great prostration, and who ultimately died after a few days apparently with severe pneumonia. No post-mortem examination was obtainable, as I could not obtain the concurrence of the coroner, but the remains of the sausage partaken of, together with other sausages of the same consignment, were sent to Dr. Klein for experiment. Some portions of the actual sausage eaten killed animals fed with it, while other portions were innocuous. Post-mortem examination of the animals that died showed hæmorrhage into the stomach, congestion of the lungs, and hyperæmia of the medullary portion of the kidneys; the most important fact, however, about these organs being that most of the urinary tubules contained casts, while many of the Malpighian corpuscles with their surrounding tissues were in a state of disintegration, without, however, any inflammatory cells being present, and indicating therefore that the disintegration was the direct result of some destructive agency circulating in the vessels.

In 1882 three instances of "food-poisoning" came under the notice of the Department, in all of which the investigations subsequently reported to them were made by the medical officer of the district, viz. :—

4. *The Oldham Case.*—In this instance "American tinned pigs-tongues" were concerned. Within half an hour of a 7-lb. tin being opened, three sales of a quarter of a pound each were made of it to three separate families, all from the top part of the tin; no more of it was sold, since the remainder was seized by the Sanitary Authority and used for analysis and experiment. One purchaser "finding the food bad" threw it away. The other two purchasers used it for the family dinner. In one of these families it was partaken of by the father and three children aged from four to eight years, the father only tasting the meat on the point of a knife; the mother ate none of it. The mother escaped illness, but all the four who ate of it were taken ill, feeling nauseated almost immediately; about four hours afterwards the children suffered from vomiting followed by severe purging, abdominal pains, and great prostration and collapse. The father, who ate the smallest quantity, did not begin to vomit for about eight hours, but his illness appears to have lasted longer than that of the children. All recovered. In the other family the food was partaken of by the mother and four children aged from 6 to 17 years. All these suffered at about the same interval after eating and with quite similar symptoms as the members of the other family; the eldest girl, who partook of it much more largely than the others, suffered most severely; she was comatose for about four hours and there were doubts as to her recovery. Dr. Sutton, who reported the case, says that "the degree of collapse was greatest where the patient "suffered least from diarrhœa. The most serious case was one in "which diarrhœa was absent and signs of recovery did not appear until

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"the bowels had been acted upon by a purgative." He adds that "it is perhaps worthy of note that the family who suffered most "severely were served with the first slices of the meat." No trace of mineral poison was discoverable on analysis of the remaining meat. With this same material Dr. Klein fed a variety of animals without injury, except that one dog suffered from diarrhœa the day after feeding, and was slightly relaxed for two or three days following. He also inoculated into guinea-pigs without result cultivations of micrococci and torula from a creamy fatty substance in which each tongue was enveloped. Either the poison that so severely affected persons eating meat from this tin had disappeared from the material by keeping a few days, or it had been confined originally to that end of the tin which was first cut from.

5. *The Bishop Stortford Case.*—This is a case in which members of three families who ate of a particular piece of ribs of beef (the rest of the carcase proving harmless) when it had become cold (not when hot and freshly cooked) were attacked. The meat was cooked on a Saturday, and its poisonous quality was more marked on the Monday than on the Sunday. There was a considerable interval (incubation period) between eating and illness; in one family in which the meat was eaten cold on the Monday at breakfast the illness did not commence until the next day. No bacterial investigation was made.

6. *The Whitchurch Brawn Case.*—This is an instructive story of the nearly simultaneous attack of members of 10 different families residing in different parts of the town, or outside the town, after eating what is locally called "brawn" (a gelatinised dish made mainly of pig's head, and eaten cold). Curiously enough, the brawn had been made and purchased at about the same time at two different shops which had no other connexion than being situated about 100 yards apart in the same street. Of the 10 families made ill, only one had partaken of the food on the day after its preparation. The others all partook of it on the second day after its preparation. The brawn was good in appearance and to the taste. The attacks commenced from one to five hours after eating. No bacterial investigation was made beyond this—that Dr. Klein found in some prepared microscopic specimens of the brawn forwarded to him by Dr. Thursfield certain bacilli looking like those he found in the Welbeck ham, but he could not say that they were identical with them. I had (during my Welbeck inquiry) met with a very similar instance of poisoning by "brawn" made and purchased at a shop in Mansfield, which I had not then the time to investigate.

7. *The Whitchurch Roast Pork Case.*—This instance of food poisoning occurred also in the town of Whitchurch, but in 1878. The material which produced the illness was a roast leg of pork (the remainder of the carcase having done no mischief). The pork was provided for a Sunday family dinner, at which it was eaten freshly cooked and hot; it was eaten cold at supper and cold again at dinner on Monday; it was eaten also cold by a man and his wife residing three miles off, both of whom died from its effects after about 30 hours illness. The others who were attacked recovered. There appears to be evidence that the pork eaten, whether hot or cold, on the Sunday did no mischief. It was not until the Monday that it made people who ate it ill. And there is this further interesting and instructive fact to be noted, viz., that those who ate the pork at dinner only on the Monday were not attacked until after an interval of 7 to 19 or more hours, while the two persons who ate it in the evening and who died, were attacked much more quickly, namely, about four hours after eating.

8. *The Wolverhampton Tinned Salmon Case.*—In May 1884 three grown-up persons at Wolverhampton ate at supper a portion of a tin of salmon, and two children merely tasted it. The tin was what is termed "a blown tin," and when opened the material was found to have been in some degree decomposed. Of the three who fed upon it, a son ate four or five ounces, a mother about a tablespoonful, and a daughter a bit of the size of a hazel nut. All were more or less affected. The son who had eaten most was attacked about 10 hours after eating it, and died in three days; the mother who ate less was attacked after 12 hours, and died in five days, and the daughter, who had eaten still less, was attacked after about 14 hours, but recovered. The two children suffered merely from transient headache the next day. An inquest was held on the fatal cases, and the coroner sought the assistance of the Department, but not until after the post-mortem examination had been made. However, portions of the stomach, liver, and kidneys were obtained and submitted for examination to Dr. Klein. In both cases the stomach showed necrosis of the superficial layer of the mucous membrane, the liver extensive fatty degeneration as in acute phosphorus poisoning, and the kidney signs of inflammation. Very little of the material remained in the tin sent to Dr. Klein, but mice fed on it speedily fell ill and died, their organs being similarly affected to those of the man and woman who died, but no micro-organism was found in them or in the blood. They had obviously been poisoned by some chemical substance.

9. *The Carlisle (A.) Case.*—In August 1886 happened what was called the "Carlisle poisoning case," which, from the specially painful circumstances attending it, attracted at the time much public attention. It was investigated by Dr. Henry Barnes, of that city, who during the whole of his inquiry was in communication with myself and my late colleague Dr. Page. At a wedding breakfast and subsequently, 24 persons in all partook of the refreshments provided, all of which were cold and had been prepared the previous day and stored for the night in an ill-ventilated cellar where (unknown to the fresh occupants of the house) meat and milk were apt to go bad. Only four of these persons escaped illness, both bride and bridegroom were attacked, and the former died in Edinburgh. No post-mortem examination was made. Dr. Barnes's suspicion was chiefly directed to the "American ham" that formed part of the refreshments provided (mainly perhaps because he was familiar with the history of the Welbeck epidemic), but there is reason to believe that this was not the only peccant article. The gelatinous articles provided—jellies and open game pie for instance—were not improbably also in fault. Three of the 20 made ill certainly ate of the food on only one occasion, viz., the bride and the bridegroom and one other person; the bridegroom was attacked after an interval of eight or nine hours, and the bride and the third person after an interval of 17 or 19 hours. The probable interval in other persons who ate of the food at more than one meal was from 6 to 43 hours. Chemical investigation indicated the presence of a toxic chemical substance in the ham (alone submitted to investigation). No bacilli were found in the ham, but Dr. Klein and Dr. Chiene, of Edinburgh, obtained from it a cultivation of micrococci which (as well as the portions of the ham with which animals were fed by Dr. Walker, of Newcastle) proved harmless to dogs, cats, and mice.

10. *The Iron Bridge Case.*—In this instance 12 individuals out of 15 in the household partook at mid-day dinner of one of two veal pies made the day before but warmed up again for the meal. Again the period which elapsed between eating the pie and commencement of illness varied. Three were attacked after six or seven hours, four after

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seven to 10 hours, and the remainder later in the night. The unused pie was forwarded to Dr. Klein after it had been kept for 13 days, and with it a portion of the raw veal from which both pies had been made. The raw veal produced no ill results on mice and a dog and a cat fed with it, nor did the pie until the feeding had been continued for three days, when two of the mice died. Post-mortem examination gave evidence of intestinal inflammation and congestion of the kidneys, but no organism was detected in the blood or viscera. This pie when opened was found to be mouldy, and there was a whitish scum which was an almost pure cultivation of a species of motile bacterium resembling the bacterium termo. From between the pieces of meat and in the jelly of the pie were obtained two kinds of motile bacillum. All these organisms were cultivated. No ill effects followed feeding or inoculation with the cultivations of any of these organisms except one, the special kind of bacterium termo just mentioned.

The following is what Dr. Klein says about it in his report on the subject to the Board:—

"This bacterium grew well and luxuriantly in nutritive gelatine, on boiled egg, in Agar-Agar meat extract peptone and on a mixture of vegetable albumen and Agar-Agar. In plate cultivation it formed whitish irregular patches; on nutritive gelatine in test tubes it grew in the shape of a white and thickish film rapidly spreading from the point of inoculation and forming a smeary paint-like growth. In thin layers the film possesses a fluorescent appearance, the nutritive material in the immediate neighbourhood of the growth assuming a bluish-green colour. This becomes diffused through the whole nutritive medium as time goes on, but remains most conspicuous near the growth. In the course of a fortnight or so the gelatine liquefies into a thick syrup-like fluid, but only where the film is very thick; in the thin parts the gelatine remains solid. The curious thing about this bacterium termo is that it does not grow in any medium at a temperature above 30° or 32° C.; at 36° to blood heat no growth takes place. At the ordinary temperature of the room it grows luxuriantly. In Agar-Agar meat extract peptone it grows very luxuriantly, forming a thick film which in the course of a few days reaches great dimensions. In broth and broth peptone (alkaline) the organism grows very copiously, forming in as short a time as two to three days a uniform turbidity, but does not at any time yield as copious a growth as, for instance, bacillus subtilis. Nor does it form anything like a pellicle on the surface of fluid media. A very interesting fact about all these cultures is that after some days' growth the cultures possess a most exquisite and delicate aromatic smell, no trace of putridity being perceptible. On solid media the organism forms chiefly coherent masses, zooglæa, the elements being oval, some constricted in the middle and held together by an interstitial hyaline or faintly granular substance; when isolated by mixing up with salt solution or in broth culture some are seen to be possessed of motility. Measurements made of specimens after drying and staining with Spiller's purple or with gentian violet or with methyl-blue (all of which dyes stain the organism readily and well), show that its length is 0·0018 m.m. and its thickness about half, *i.e.*, 0·0009 m.m.; it is rounded at the end, and in the stained specimen shows, like other bacterium termo, a middle part not stained, and at each end a stained protoplasm; a common sheath surrounds the whole organism."

"Experiments were now made with the pure cultivation of this bacterium termo. As might be expected from the fact above stated that it does not grow at blood heat, subcutaneous inoculations into mice produced no result. Mice were then fed several days with cultures in broth or broth peptone or gelatine (the latter previously liquefied by gentle heat); in this way the contents of a culture tube are mixed with a little milk and this mixture is allowed to soak into

bread. The result was this:—Two mice were fed on June 15 with broth culture prepared in the manner just stated. Next day, *i.e.*, June 16, they were quiet and somewhat drowsy; on this day fed them again with gelatine culture. One mouse died in the evening of June 17, the other was found dead in the morning of June 18. In both cases post-mortem examination revealed severe gastritis with hæmorrhage into the cavity of the stomach, severe enteritis, much sanguineous mucus in the cavity of the small intestine; kidneys congested; liver and both lungs congested; spleen small. No bacterium termo to be found in any of the viscera. On June 18 fed four mice with mixture of broth culture and gelatine culture. On the same evening, and more distinctly on June 19, all four mice were found manifestly ill; the animals were very quiet and drowsy, their eyes closed, and their coats rough. On the following morning, *i.e.*, June 20, they were again normal and lively.

"It follows from this that the cultures of this bacterium contained a substance which when introduced into the stomach produced illness and death, in the latter event severe gastro-enteritis being a conspicuous feature. Since the organism in itself is harmless, not being capable of growth and multiplication at the temperature of the animal body, it follows that this poisonous substance is non-organised and produced by the above bacterium termo."

This case, therefore, shows this further, that where the poisonous element of the food is a chemical poison, it need not always operate immediately, but that its ill effects may be delayed for 10 or 12 hours. The culture characteristics of this bacterium will be found briefly alluded to, in connexion with those of the bacillus in the Retford case to be next mentioned, at page 117 of the 17th Report of the Medical Officer of the Board.

11. *The Retford Case.*—This case was investigated for the Board by my late lamented colleague, Mr. Spear. It occurred in November 1887, when 80 persons in 22 different families were made ill, and one of them died, from eating pork pie or "brawn" bought on one or other of two days at some co-operative stores there. The material was cut up on the 9th, the pies and brawn were cooked on the 10th, and they were eaten on the 11th, 12th, 13th, 14th, and later. It is to be noted that, with the exception of one family, none who ate of this food stuff on the 11th (the first day after cooking) were taken ill: and further that none who ate of it after the 14th (the fourth day after cooking) were taken ill. Here again the interval between eating and illness was various. Out of 59 cases in which it was determined, 4 individuals were attacked after an interval of less than 8 hours, 6 after an interval of between 8 and 12 hours, 19 between 12 and 24 hours, and 30 between 24 and 36 hours after eating. Unfortunately the report does not state, respecting those who were attacked at short intervals after swallowing the implicated food, whether they belonged to families who obtained and used it at an early or at a late date after it was cooked at the "Stores." One of the pork pies forwarded to Dr. Klein on December 1st (three weeks after cooking) was found to contain a brown viscid scum "made "up almost entirely of minute thick rods, some of which were motile "and of the kind now spoken of as short bacilli," the streak cultivation of which on nutritive gelatine begins to assume after 24 hours a blue colour, which Dr. Klein says is extremely characteristic. It was not the same bacillus as was found in the Iron Bridge case, partly differing from it in this, that it readily grows at the temperature of the body. Feeding with the pie material made six mice ill and killed one of them, as also did feeding with a gelatine culture of the bacillus; post-mortem examination of the mice revealed gastro-enteritis with hæmorrhage and

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congestion of the spleen, liver, lungs, and kidneys. Inoculation of mice with a three-days' old cultivation of the bacillus on gelatine produced in them effects similar to those obtained by feeding. Cultivation of the heart's blood of the experimental mice, in tubes of nutritive gelatine, yielded no growth of any kind, but from the pleural exudation of one of them vigorous cultures of the bacillus were obtained, which on inoculation in other mice proved pathogenic. In connexion with cultures of this bacillus, a very striking difference was met with, viz., that the material of cultures 10 days to a fortnight old was absolutely without effect on mice fed or inoculated with considerable quantities of it. This non-pathogenicity of cultures was not due to the death of the bacillus; rather it would appear that the chemical substance poisonous to mice is produced by the bacillus only at a very early period and for a very limited time in these subcultures. Note in connexion with this fact the other observation made by Mr. Spear, that persons who ate of the food-stuff after the fourth day from cooking were not made ill by it.

12. *The Carlisle* (*B.*) *Case.*—During the first week or 10 days of November 1889 a number of persons of different families, some residing in the city of Carlisle and some outside the city, were seized with diarrhœal illness after eating pork pies or boiled salted pork purchased at one or other of five establishments in different parts of Carlisle. Two of these establishments belonged to a butcher who made pork pies, and sold also boiled salted pork; the other three establishments belonged to a Cocoa-house Company who purchased pork of this butcher, and had pork pies made of it at their bakery, from which these three shops were supplied. The particular pork which produced mischief appears to have been made into pies on Friday, November 1st, having been killed two or three days previously. The people, numbering 25 or more, who suffered from the diarrhœal illness appear to have eaten of one or other of these materials at dates from November 1st up to November 11th, and very generally there was an interval of not less than 24 hours between the eating of the food and the commencement of the serious indisposition. This is about as much information of the circumstances of the outbreak as can be gathered with precision of detail from the account of it in the Board's possession. The Medical Officer of Health transmitted to Dr. Klein on November 25th samples of salted pork from all the pigs the butcher had slaughtered from October 28th to November 4th, and a sample of gravy-stock used by him in making pies. None of the pork pies of the batches which appeared to have been poisonous were obtainable. It must be added that it could not be affirmed that the gravy-stock which was sent to Dr. Klein was the same with that which had been in use for the particular pork pies and which had seemed to produce illness. Mice fed with the pork or with the gravy-stock on the second or third day from eating, had diarrhœa with fluid sanguineous evacuations, and died, and presented *post-mortem* identical appearances. The whole of the small *intestine* was relaxed and congested, and its cavity was filled with sanguineous mucus. Both *lungs* were deeply congested, and in the mice that survived longest there was hepatisation chiefly in the upper lobes. The *liver* was congested; in one animal only (a mouse dying on the sixth day after feeding with the pork) were there present numerous whitish-grey specks in that organ. The *spleen* was congested in all; in a few cases only was it in addition very slightly enlarged.

Gelatine cultures inoculated with juice from the diseased lung afforded in the case of every one of these mice an organism which proved to be a minute motile bacillus, which is fully described in Dr.

Klein's report. The following is Dr. Klein's summary of the results of his experiments :—

"1. The stock-gravy and the pork were alike capable of producing illness and death in mice fed with these materials.

"2. The illness and death thus produced could hardly have been due to a chemical poison, for the induced disease did not set in until the second day after experimental feeding; there was, in fact, a definite incubation period of not less than 24 hours in all cases.

"3. The symptoms noticed during illness, and the appearances observed after death, indicated severe intestinal disturbance and congestion of the lungs.

"4. In the congested lung were present numerous bacilli of a single species that had definite cultural characteristics.

"5. The bacillus thus obtained when introduced, whether by feeding or by inoculation into other mice, produced in them illness and death,—with the same symptoms and pathological appearances as had been observed in mice fed directly with the pork or with the gravy-stock under suspicion. And further, from the bodies of the mice dead after feeding or inoculation with cultures of the bacillus, that organism was recoverable in abundance by appropriate methods.

"To sum up:—We have then to do here with a true infectious disease producible in the first instance by feeding animals with given samples of gravy-stock and of pork, and capable of being propagated by a particular microbe isolable in artificial culture from the bodies of the rodents fed with the samples. The microbe here described is not the same as that described by me 10 years ago in connexion with the Welbeck and Nottingham meat poisoning; nor is it identical with either of those to which veal and pork pie poisoning has been referred by me in recent reports to the Medical Officer. It is an altogether different species, as will be clear from my account of its morphological and cultural characters."

Dr. Klein was further able to isolate the microbe from the gravy-stock, but was less fortunate in the case of the pork which had become mouldy by the time he had come to recognise it.

13. *The Portsmouth Case.*—Since this instance of food poisoning is fully reported at p. 249 of this volume, it is merely requisite to note here the following points:—One afternoon in February, 13 persons, nine boys and four grown-up persons, partook of cold meat pie, made and cooked the day before. One of the boys ate none of the meat but only the paste and gravy, and one grown-up person scarcely touched what was given him. The last-mentioned person escaped illness, but all the others were taken ill in the night or early morning, *i.e.*, 14 to 17 hours after the meal, with abdominal pains, diarrhœa, headache, and malaise: all recovered. The same paste, used for treacle pie and tartlets eaten by other persons, had produced no mischief, so that the peccant material would appear to have been the meat or the gravy; the chief suspicion falling upon the gravy, since one boy who ate only paste and gravy became as ill as the rest. Portions of the cut pie and of a pie that had not been cut into, with a good deal of adherent jelly, were submitted to Dr. Klein for experiment. The pies when first received proved poisonous to mice, but five days later when the material had become offensive from putrefaction were poisonous no longer. Microscopical examination of the jelly showed two species of baccilli, one, *a*, non-mobile, broth cultivations of which had a rather pleasant aromatic odour, and the other, *b*, mobile, rapidly liquefying gelatine and producing an offensive odour. By direct experiment, feeding mice on broth culture of these bacilli, the culture of species *b* was found to be harmless; but that of species *a* was found poisonous, and certain of the mice thus fed

died. Inoculations of the broth culture of species *a*, however, had no effect. In the dead animals the lungs were found dark red and almost hepatised, liver, spleen, and kidneys dark, spleen not enlarged: the small intestine relaxed and full of mucus. From only one of the mice that died could the bacillus be recovered. The inference drawn by Dr. Klein is that the bacillus itself was not pathogenic on inoculation, but that what produced illness and death was a chemical poison formed by it in culture. He adds the remark that this organism *a* is morphologically and culturally different from the species found in the Retford, Shrewsbury (Iron Bridge), and Carlisle materials respectively.

I have only one more instance of meat infection to narrate among such as have come under the notice of the Medical Department. And this relates not to illness of a gastro-enteric character, but to pneumonia.

14. In the early part of 1888 a very severe epidemic of "pneumonia" at Middlesbrough in Yorkshire was notified to the Board by the medical officer of health, who, with the sanitary authority, desired the Board's assistance in its investigation. This inquiry was intrusted to me. In the town and three adjoining districts 490 deaths were registered as from pneumonia during the year in a population of about 98,000, and these chiefly in the families of labourers, iron workers, and persons of working age. The prevalent disease was proved incontestably to be of infectious character, communicable from person to person by proximity, through the medium of sewer air and in other ways in which other infectious fevers are known to be spread. But all this left unexplained a curious geographical limitation of the epidemic which puzzled me greatly, until calling to mind some old experiences I began to study the food and mode of life of the classes principally attacked. I then ascertained the fact that during the greater part of every week nearly the only animal food these people got was what is termed "American bacon" (made by soaking in water, and then only slightly drying, salted pork imported from America); and the fact also that the limitation of the epidemic corresponded closely with a similar geographical limitation of the wholesale trade of a manufacturer of this bacon in the town of Middlesbrough, who in the affected districts had by far the largest portion of this trade in his hands. In view of these facts, I, in sending to Dr. Klein for examination and experiment fresh portions of viscera (as well as hardened portions) of persons dead with the malady, also forwarded to him specimens of the suspected bacon of which sick persons had recently eaten, and as well samples of bacon purchased at different retail shops in the district. The result of Dr. Klein's work upon these several materials was briefly this:—The disease I was dealing with turned out, as I suspected, no new local malady, but a specific general disease or fever marked, as other general specific diseases, by destructive morbid changes in all the principal viscera, the special characteristic of which in this case was a pleuro-pneumonia. In the lung juice and in the lung tissue Dr. Klein discovered a hitherto undescribed short bacillus which he has called "bacillus pneumoniæ," differing altogether from the bacillus of Friedländer and the "diplococcus pneumoniæ" of Fränkel and Wiechselbaum, neither of which was present. Of 20 samples of bacon forwarded from the infected districts, 13 were distinctly poisonous to rodents fed with it, in 2 instances there was some doubt, and only 5 proved not to be poisonous.* In the dead animals were found lung lesions and lesions of other viscera similar to

* The presence of bacillus in the actual samples of bacon was matter of inference rather than of observation, but Dr. Klein had no doubt of the virus having been derived from the bacon and from it only.

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those observed in persons who died of the pneumonia disease in the infected districts. Similar results followed inoculation into rodents of the human lung juice and of pure cultivation of the bacillus pneumoniæ. In all instances the bacillus was recoverable from their bodies. An instructive incident in Dr. Klein's part of the investigation was this, viz., that during its progress an epidemic of pneumonia occurred among the animals, mice, guinea pigs, and monkeys kept in the building where his experiments were carried on, the bacillus pneumonia being found after death in their lung juice and sometimes in their heart's blood also. Another fact must be mentioned, namely, that on re-examination, after the lapse of three months, of samples of the bacon that had previously produced illness and death, they were found to have lost their powers of infecting animals, and no growth of the bacillus was obtainable from them on culture media. The details of the evidence connecting the use of the suspected kind of bacon and the occurrence and limitations of the epidemic pneumonia, will be found in my detailed report on the epidemic in the 18th Annual Report (1888) of the Medical Officer of the Board.

Certain inferences appear to be suggested by the cases above narrated, and by the investigations pursued by Dr. Macfadyen and others.

1. I may quote the words of the Medical Officer of the Board. He says (19th Report, p. xiii.) :—"The phenomena which we speak of as "'food-poisoning' productive now of one and now of another sort of "definite malady among consumers of certain foods are claiming, on "ever-growing evidence, to be regarded as true infective diseases, as "much so as scarlatina or tuberculosis. That they have not been "generally admitted into this rank arises, first, from the circumstance "that some of them have seemed to be wanting in an incubation period; "and secondly, because they are rarely recognised as transmissible "from person to person. But from our researches of this very year "[1889] we derive some new considerations that materially affect the "importance of incubation, as determining the infective nature of a "poison; while we need go no further than the experiences of "Middlesbrough in 1888 to find suggestion of disease-bacteria "operating alternatively through the atmosphere and through infection "of food material by them."

2. In food capable of producing on being eaten disease or illness of the sorts described, we ascertain the presence of one or both of two things—a living microscopic organism and an organic chemical poison of greater or less virulence.

3. Of these two things, that which is immediately operative in the production of the morbid phenomena is the chemical poison which is apparently of a basic nature and a product of the processes of bacterial life.

4. Specifically different bacteria capable of producing this chemical poison may, it would seem, through its agency give rise in the human system and in animals to clinical phenomena and pathological changes in the organs which are so similar that at present they cannot be distinguished.

5. Given the bacterium and favourable environment, the bacterium may grow, multiply, and produce its own special chemical poison from the material which affords it nourishment, either outside the body or within it. One important element of environment is temperature. If a bacterium will not grow at the temperature of the body, it of course will not produce its operative chemical poison when introduced into the system. (See instance 10. the Iron Bridge case.)

6. Moreover, both the bacterium that produces the chemical poison in an infected food and the chemical poison itself may apparently be evanescent; perhaps in the former case the bacterium being killed by its own products, and perhaps in the latter case, because the chemical poison undergoes destructive chemical changes. (See instance 13, the Portsmouth case.) Welbeck ham lost its infective power when exposed for a time to sewer air. Hence an infected food poisonous when eaten at one time may fail to be poisonous when eaten at a later period, or poisonous when inoculated at one time may cease to be so later on; or one portion of an infected mass of food may be poisonous, and another part not be so. (See in this connexion Cases 3, 4, 11, 13, and 14, the Chester, Oldham, Retford, Portsmouth, and Middlesbrough instances.)

7. Reference has been made above to the absence in some instances of anything like the incubation period which precedes the characteristic phenomena of other better known or hitherto recognised specific maladies. But it is to be observed that in many cases of food poisoning an incubation period has been distinctly traced, in others it has been less obvious; in some there was practically none, only from half an hour to a few hours elapsing between taking the food and the initial symptoms of the malady. The presence of incubation period may be taken as clinical evidence of the symptoms being due to the operation within the body of the bacterium itself, and absence of incubation period as indicating the operation of the chemical poison already existing in the food at the time it was swallowed. Where merely the bacterium is introduced, time is required as in other specific infections for the growth and multiplication of the micro-organism in the body, and for formation there of its poisonous chemical product. When the chemical poison already prepared outside the body is introduced, it operates more speedily, the rapidity of the operation being proportional to its quantity and quality, and to the individual peculiarities of the recipient. In the several series under consideration the instances of long incubation (where it has been possible to ascertain the fact) occurred in cases where there was no doubt of bacteria having been introduced into the system, as in the Welbeck and Nottingham ham and pork cases. I had reason to think that in the case of the Middlesbrough bacon the incubation period was 18 to 36 hours, or perhaps a little longer. On the other hand, where no bacterium had been introduced along with the food (or one which would not grow at the temperature of the body), as in the Chester sausage case, the Wolverhampton tinned salmon case, and the Iron Bridge veal-pie case; or where the bacterium introduced with the food was not pathogenic within the animal body, as in the Portsmouth instance,—the illness induced by the food commenced at periods varying from half an hour to 10, 12, 14, or 17 hours only after it had been eaten. But in some of these food-poisoning series of cases there were individuals who suffered quickly and others who suffered after a longer interval. It was so in the Welbeck series of cases, where the interval varied from less than 12 hours to more than 48 hours; in the Nottingham pork case, where it varied from about 12 to 34 hours; in the Whitchurch pork case (No. 7), from 7 to over 19 hours; in the Carlisle (A.) case from 6 to 43 hours; and in the Retford case from under 4 to about 36 hours after eating. The interpretation of these varieties appears to be that, in the food eaten, the bacterium capable of developing in the body and the chemical poison already formed in the food were not equally distributed through the mass of the material, one individual case getting more of the one and another more of the other in the portion given him. Where, as in the Whitchurch pork case (No. 7), persons who fed upon the food latest had the shortest interval and the most severe attack,

the interpretation may be that the individuals who fed at an earlier period got the bacillus in an active stage, when little of the chemical poison had been produced in the food, and those who fed later on got a larger dose of the chemical poison for the more abundant production of which by the bacterium time had been afforded by the postponement of the eating.

8. One word more about the kinds of animal food which in the above series of instances would seem to have produced mischievous or fatal results. Of the 13 instances the food was or consisted largely of—

| | |
|---|---|
| Pig-meat of one kind or another in | 10 instances. |
| Veal - - - | 1 instance. |
| Beef - - - | 1 ,, |
| Butcher's meat (kind unstated) | 1 ,, |
| Tinned salmon - - | 1 ,, |

I am disposed to think that this is no unfair representation of the relative frequency with which swine's flesh thus gives rise to specific diseases of the kinds referred to, as compared with animal food from other sources. Certainly, apart from these instances, this corresponds with my general experience, and I suspect the experience of the profession at large. What explanation can be offered of this? There is no reason whatever to believe (quite the contrary) that the food in any of the instances above recorded contained the specific micro-organism before it was prepared for food. The American pork that, converted into mild bacon at Middlesbrough, was a means of conveying to persons eating it a specific pneumonic fever was obtained from American firms at Chicago and elsewhere of the highest repute, and consignments of the same brand at about the same time to other similar bacon makers at Stockton, only a mile or two distant, did not spread any epidemic, so far as I could learn, among its consumers; nor did other hams or bacon than those which produced disease at Welbeck, although made from the same consignment of American pork, produce similar disease to the Welbeck epidemic. And it is to be noticed that in the Nottingham pork case and the Bishop Stortford beef case (No. 5) other portions of the carcases were eaten harmlessly. And this is an observation I have made in other instances of food-poisoning within my experience. The truth of the matter seems to be that the accession of the specific bacillus to the food is what we commonly call "accidental," which of course only means in this case that it comes from somewhere beyond our present knowledge. We do not know its normal habitat, but assuredly it now and then becomes air-borne, infects food of a kind that affords it appropriate nutriment, multiplies and produces its appropriate chemical poison there, and produces its appropriate specific disease in persons who consume the infected food. I have elsewhere suggested a similar hypothetical explanation of epidemic summer diarrhœa, another unquestionable specific disease. But if we do not know where the normal home of the bacillus is, nor how it escapes to do mischief, we do know something about the circumstances under which it gains access to food, which may help to elucidate even this point. It is to be noted that in every instance except one (No. 2), the Nottingham pork case, it was food that had been prepared a day or longer previously to its consumption, stored in one way or another, and then eaten cold, which produced disease. I may add here parenthetically that in the Nottingham pork case, where the pork was dispensed hot, I had reasons for suspecting that it was not the flesh of the pork that actually produced the disease, but a gelatinous stock or gravy warmed and served with it that was really the peccant material. And it is the conditions under which the preparation of the

food took place, and under which it was subsequently stored, that, in certain of the instances narrated, served to furnish a clue to the knowledge we want. The observations made indicate an infectiveness of the place where these things were done, in association with uncleanliness of air, of soil, or of surface. I must be content to refer to my reports on the Welbeck and Nottingham cases, and to my summary of the Carlisle (A.) case, as evidence of this, and notably to my report on the Middlesbrough outbreak, where the circumstances of the processes of bacon making at Middlesbrough and Stockton are contrasted. Still, all this does not explain the special liability of pig-meat to produce these specific maladies. How is this to be accounted for? I have been disposed to gather a suspicion of what the explanation is from what I have said above about the Nottingham pork case, viz., that it was perhaps the gelatinous gravy and not the flesh of the pork that was really the peccant material. I could not hear of anyone having been made ill by eating the pork served to them after it had become cold, which of course would have been without gravy. And the explanation I have to suggest is this, that of all adult flesh meats commonly eaten, pork under the process of cooking furnishes the largest proportion of gelatine. Young meats, such as veal (used in the Iron Bridge case), are also largely productive of gelatine: and gelatine is a favourite nutriment of morbific bacilli. We may note here how many of the articles of food most generally partaken of at the Carlisle wedding breakfast were gelatinous or gelatinised. These were the cold American ham, which moreover was glazed on the surface with gelatine, the game pie, the cold boiled salmon, and, among the sweets, the jellies and the trifles. Of two or more of these everyone that was taken ill had partaken. The Portsmouth case illustrates the same point, since a boy who ate nothing but gelatinous gravy (with pie-crust that was beyond suspicion) was made as ill as others who had eaten the meat of the pie.

9. And yet another word, before I conclude, on the practical application of all this. What does it all indicate as an efficient precaution against "food-poisoning"? Of course no one is likely to be hindered by any fear of infection from eating cold ham or gelatinised food of any kind if he likes them. But if we do eat ham or bacon, cold or warm, it is a proper precaution to avoid them if not duly cooked throughout. The people who chiefly got pneumonia in Middlesbrough were a class who habitually only warmed the bacon they ate by slightly toasting it before a fire; they did not heat it sufficiently to kill any micro-organism; and hotel hams (indeed hams cooked at home too) are rarely thoroughly cooked. But the grand precaution of all is the very commonplace one, signified by the word *cleanliness*. Every factory where pork is converted into brawn or hams ought to be so arranged that light and a draught of air can penetrate freely everywhere; there should be no corners where refuse matter can lodge and become a centre for the cultivation of morbid micro-organisms in filth, the rise of ground air should be obviated by cement under the pavement or flooring; and the place should be kept scrupulously clean and free from incursion of sewer air or unwholesome emanations of any kind. Kitchens, and above all pantries and places where food is stored in hotels, public refreshment rooms, or pastrycooks' premises, and in private houses, should be similarly cared for. It should be held to be part of the business of conservators of public health to see that these rules are observed, as well as the business of every master or mistress of a family.

## No. 22.

### General Cholera Order of August 28th, 1890.

### To all Port Sanitary Authorities.

To all other Sanitary Authorities as herein defined;—
To the Queen's Harbour Masters of Dockyard Ports;—
To all Officers of Customs;—
To all Medical Officers of Health of the Sanitary Authorities aforesaid;—
To all Masters of Ships;—
To all Pilots;—
And to all others whom it may concern.

Whereas we, the Local Government Board, are empowered by section 130 of the Public Health Act, 1875, from time to time to make, alter, and revoke such regulations as to us may seem fit, with a view to the treatment of persons affected with cholera, and preventing the spread of cholera, as well on the seas, rivers, and waters of the United Kingdom, and on the high seas within three miles of the coasts thereof, as on land; and may declare by what authority or authorities such regulations shall be enforced and executed;

And whereas by section 2 of the Public Health Act, 1889, it is enacted that regulations of the Local Government Board made in relation to cholera and choleraic diarrhœa, in pursuance of section 130 of the Public Health Act, 1875, may provide for such regulations being enforced and executed by the Officers of Customs, as well as by other authorities and officers, and without prejudice to the generality of the powers conferred by the said section, may provide for the detention of vessels and of persons on board vessels, and for the duties to be performed by pilots, masters of vessels, and other persons on board vessels; provided that the regulations, so far as they apply to the Officers of Customs, shall be subject to the consent of the Commissioners of Her Majesty's Customs;

And whereas by certain orders dated the 12th day of July 1883, and an order dated the 21st day of April 1884, we prescribed rules and regulations with a view to the treatment of persons affected with cholera, and for preventing the spread of the disease, and it is expedient that such orders should be revoked, and that further regulations should be prescribed as herein-after mentioned, to which the Commissioners of Her Majesty's Customs have signified their consent so far as such regulations apply to the Officers of Customs:

Now therefore, we, the Local Government Board, do hereby revoke the aforesaid orders, except in so far as they may apply to any proceedings now pending, and we do, by this our order, and in exercise of the power conferred on us by the Public Health Act, 1875, as amended and extended by the Public Health Act, 1889, and every other power enabling us in that behalf, make the following regulations, and declare that they shall be enforced and executed by the authorities herein-after named:—

### *Definitions.*

Art. 1.—In this order—
The term "ship" includes vessel or boat;
The term "Officer of Customs" includes any person acting under the authority of the Commissioners of Her Majesty's Customs;
The term "master" includes the officer, pilot, or other person for the time being in charge or command of the ship;

The term "cholera" includes choleraic diaarhœa;

The term "Sanitary Authority" means every Port Sanitary Authority and every Urban or Rural Sanitary Authority whose district includes or abuts on any part of a customs port, which part is not within the jurisdiction of a Port Sanitary Authority;

The term "Medical Officer of Health" includes any duly qualified medical practitioner appointed by a Sanitary Authority to act in the execution of this order;

For the purposes of this order—

(1.) So much of a customs port abutting on an urban or rural sanitary district as is nearer to such district than to any other, and is not included within the jurisdiction of any Port Sanitary Authority, shall be deemed to be within such district;

(2.) Every ship shall be deemed infected with cholera, in which there is or has been during the voyage or during the stay of such ship in a port in the course of such voyage, any case of cholera.

I.—*Regulations as to detention by Officers of Customs.*

Art. 2.—If any Officer of Customs, on the arrival of any ship, ascertain from the master of such ship or otherwise, or have reason to suspect that the ship is infected with cholera, he shall detain such ship, and order the master forthwith to moor or anchor the same in such position as such Officer of Customs shall direct; and thereupon the master shall forthwith moor or anchor the ship accordingly.

Art. 3.—Whilst such ship shall be so detained, no person shall leave the same.

Art. 4.—The Officer of Customs detaining any ship as aforesaid shall forthwith give notice thereof, and of the cause of such detention, to the sanitary authority of the place to which the ship shall be bound, or where the ship shall be about to call.

Art. 5.—Such detention by the Officer of Customs shall cease as soon as the ship shall have been duly visited and examined by the Medical Officer of Health; or if the ship shall, upon such examination, be found to be infected with cholera, as soon as the same shall be moored or anchored in pursuance of Art. 10 of this order.

Provided, that if the examination be not commenced within twelve hours after notice given as aforesaid, the ship shall, on the expiration of the said twelve hours, be released from detention.

II.—*Regulations as to Sanitary Authorities.*

Art. 6.—Every Port Sanitary Authority and every other Sanitary Authority within whose district persons are likely to be landed from any ship coming foreign shall, as speedily as practicable, with the approval of the Chief Officer of Customs of the port, fix some place where any ship may be moored, or anchored, for the purpose of Art. 10; and shall make provision for the reception of cholera patients and persons suffering from illness removed under Arts. 13 and 14. The place to be fixed as aforesaid, where any ship may be moored or anchored for the purpose of Art. 10, shall be some place within the jurisdiction or district of the Sanitary Authority, unless the Local Government Board otherwise consent; in which case the place so fixed shall, for the purposes of this order, be deemed to be within such jurisdiction or district.

Provided that in the case of any dockyard port for which a Queen's harbour master has been appointed the place where any ship shall be moored or anchored for the purpose of this Article shall from time to time be fixed by the Port Sanitary Authority with the approval of the

Queen's harbour master instead of with that of the Chief Officer of Customs of the port.

Provided also, that where, in pursuance of any of the above-cited orders, places have been duly fixed for the mooring or anchoring of ships for the like purpose, such places shall be deemed to have been so fixed in pursuance of this order.

Art. 7.—The Sanitary Authority, on notice being given to them by an Officer of Customs, under this order, shall forthwith cause the ship in regard to which such notice shall have been given, to be visited and examined by their Medical Officer of Health for the purpose of ascertaining whether she is infected with cholera.

Art. 8.—The Medical Officer of Health, if he have reason to believe that any ship coming or being within the jurisdiction or district of the Sanitary Authority, whether examined by the Officer of Customs or not, is infected with cholera, shall, or if she have come from a place infected with cholera, may visit and examine such ship for the purpose of ascertaining whether she is so infected; and the master of such ship shall permit the same to be so visited and examined.

Art. 9.—If the Medical Officer of Health on making such examination as aforesaid (whether under Article 7 or under Article 8), shall be of opinion that the ship is infected, he shall forthwith give a certificate in duplicate in the following Form, or to the like effect, and shall deliver one copy to the master, and retain the other copy or transmit it to the Sanitary Authority. He shall also give to the Local Government Board information as to the arrival of the ship and such other particulars as that Board may require.

*Certificate.*

_____ *day of* _____ 189 .

_____ Sanitary Authority of _____.

I hereby certify that I have examined the ship , of , now lying in the port of [*or detained at* ] and that I find that she is infected with cholera.

_____

*Medical Officer of Health* [or Medical Practitioner appointed by the Sanitary Authority].

Art. 10.—The master of any ship so certified to be infected with cholera shall thereupon moor or anchor her at the place fixed for that purpose under Art. 6, and she shall remain there until the requirements of this order have been duly fulfilled.

Art. 11.—No person shall leave any such ship until the examination herein-after mentioned shall have been made.

Art. 12.—The Medical Officer of Health shall, as soon as possible after any such ship has been certified to be infected with cholera, examine every person on board the same, and in the case of any person suffering from cholera or from any illness which the Medical Officer of Health suspects may prove to be cholera, shall certify accordingly; and any person who shall not be so certified by him shall be permitted to land immediately on giving to the Medical Officer of Health his name and place of destination, stating, where practicable, his address at such place.

The name and address of any such person shall forthwith be given by the Medical Officer of Health to the clerk to the sanitary authority, and such clerk shall thereupon transmit the same to the Local Authority of the district in which the place of destination of such person is situate.

In this Article the term "Local Authority" means any Urban or Rural Sanitary Authority; and in the administrative county of London,

the Commissioners of Sewers, the vestry under the Metropolis Management Act, 1855, of a parish in Schedule A., and the district board of a district in Schedule B. to that Act, as amended by the Metropolis Management Amendment Act, 1885, and the Metropolis Management (Battersea and Westminster) Act, 1887, and the Woolwich Local Board of Health.

Art. 13.—Every person certified by the Medical Officer of Health to be suffering from cholera shall be removed, if his condition admit of it, to some hospital or other suitable place appointed for that purpose by the Sanitary Authority ; and no person so removed shall leave such hospital or place until the Medical Officer of Health shall have certified that such person is free from the said disease.

If any person suffering from cholera cannot be removed, the ship shall remain subject for the purposes of this order, to the control of the Medical Officer of Health; and the infected person shall not be removed from or leave the ship, except with the consent in writing of the Medical Officer of Health.

Art. 14.—Any person certified by the Medical Officer of Health to be suffering from any illness which such Officer suspects may prove to be cholera, may either be detained on board the ship for any period not exceeding two days, or be taken to some hospital or other suitable place appointed for that purpose by the Sanitary Authority, and detained there, for a like period, in order that it may be ascertained whether the illness is or is not cholera.

Any such person who, while so detained, shall be certified by the Medical Officer of Health to be suffering from cholera, shall be dealt with as provided by Art. 13 of this order.

Art. 15.—The Medical Officer of Health shall, in the case of every ship certified to be infected, give directions, and take such steps as may appear to him to be necessary, for preventing the spread of infection, and the master of the said ship shall forthwith carry into execution such directions as shall be so given to him.

Art. 16.—In the event of any death from cholera taking place on board such ship while detained under Art. 10, the Master shall, as directed by the Sanitary Authority or the Medical Officer of Health, either cause the dead body to be taken out to sea, and committed to the deep, properly loaded to prevent its rising, or shall deliver it into the charge of the said Authority for interment; and the Authority shall thereupon have the same interred.

Art. 17.—The master shall cause any articles that may have been soiled with cholera discharges to be destroyed, and the clothing and bedding and other articles of personal use likely to retain infection which have been used by any person who may have suffered from cholera on board such ship, or who, having left such ship, shall have suffered from cholera during the stay of such ship in any port, to be disinfected or (if necessary) destroyed; and if the master shall have neglected to do so before the ship arrives in port, he shall forthwith, upon the direction of the Sanitary Authority or the Medical Officer of Health, cause the same to be disinfected or destroyed, as the case may require ; and if the said master neglect to comply with such direction within a reasonable time, the Authority shall cause the same to be carried into execution.

Art. 18.—The master shall cause the ship to be disinfected, and every article therein, other than those last described, which may probably be infected with cholera, to be disinfected or destroyed, according to the directions of the Medical Officer of Health.

III.—*Flag to be hoisted by Ships infected with Cholera.*

Art. 19.—The master of every ship infected with cholera shall, when within three miles of the coast of any part of England or Wales cause to be hoisted the commercial code signal Q, being a yellow flag, under the National Ensign, and shall keep the same displayed during the whole of the time between sunrise and sunset.

Given under the Seal of Office of the Local Government Board, this twenty-eight day of August, in the year One thousand eight hundred and ninety.

(L.S.) Chas. T. Richie,
President.

Hugh Owen,
Secretary.

Notice.—The Public Health Act, 1875, provides by section 130 that any person wilfully neglecting, or refusing to obey or carry out, or obstructing the execution of any regulation made under that section, shall be liable to a penalty not exceeding fifty pounds.

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Memoranda as to Annual Reports of Medical Officers of Health.

## Memoranda as to Annual Reports of Medical Officers of Health.

Every Medical Officer of Health, appointed under order of the Local Government Board, is required to make an annual report with regard to each sanitary district, or division of a district, which is under his superintendence. This report is to be for the year ending the 31st of December, or, if the officer at that date has not been in office for a whole year, then for so much of the year as has elapsed since his appointment. The report is to be made to the Sanitary Authority, and the Medical Officer of Health himself should send a copy of it to the Local Government Board and to the county council or county councils of the county or counties within which his district may be situated. It should be made as soon as practicable after the expiration of the year to which it relates. The Medical Officer of Health ought not, in general, to have any difficulty in doing this within a month or six weeks; but if from any special circumstances the report cannot be completed within six weeks, it should be understood that the delay must not be indefinite, and that the report, complete or incomplete, should be in the hands of the Sanitary Authority within, at most, three months from the end of the year. The Board's copy of the report should be forwarded to them when the original is sent to the Sanitary Authority, except where the report is likely to be printed by order of the Authority. In such cases the Board need only be supplied with a printed copy. But in all cases in which the report cannot be sent to the Board within six weeks from the end of the year they should be informed by the Medical Officer of Health as to the reason for the delay.

Art. 18 (section 14) of the Board's order of March 1891 specifies the information to be contained in the annual report, and is printed below.

The report should be chiefly concerned with the conditions affecting health in the district and with the means for improving those conditions. It should consider these subjects with reference to the past and future as well as to the particular year, and the account of the sanitary state of the district generally should, while marking the point that has been reached in the sanitary state and administration of the district, indicate directions for further consideration and action. The sanitary history of the year under review should include a record alike of the proceedings of the Medical Officer of Health himself and of the proceedings taken under his direction or advice. And the tabular statements of sickness and mortality in the district during the year, to be made on the forms supplied for the purpose, should be the subject of comment in the text of the report, in so far as deductions from them may assist the Sanitary Authority to an appreciation of the lines of action needful in the future.

The Medical Officer of Health, in reporting his proceedings and advice, will find it advantageous to follow, in the main, the order in which the subject matters of his duty appear in the several paragraphs of Art. 18, and herein special care should be taken in reporting on the influences affecting or threatening to affect injuriously the public health within the district, and causes, origin, and distribution of disease within the district, may usefully be the subjects of annual record: and an account be given both of the actual circumstances of the time, and also of any improvement or deterioration that has occurred during the

past year in conditions conducive to health or disease. For example, a vigilant health officer has in his annual report opportunity for stating and restating facts as to water supplies and house construction, conditions of storage and of removal of excremental and other refuse customary in the district; together with facts as to the adequacy or inadequacy of isolation and disinfection in the district, and the like. And such a Health Officer, reporting on the diseases and their causes within the district, will generally have some instructive details to give, either of conditions newly productive of disease, or of matters that have been remedied with advantage to the public health. In reporting upon section 3, not only should the fact of having made systematic inspections, but the outcome from those inspections should be duly put on record. They are inspections independent of such inquiries as, under other articles of the order, the Medical Officer of Health has to make into particular outbreaks of disease, or into unwholesome conditions to which his attention may have been specially called by complaints or otherwise; and will include the house-to-house inspections which may be necessary in particular localities.

Of these inspections, systematic and occasional, and of the judgment he has formed thereon as to the sanitary state of his district, and of the advice he has in consequence given to the Sanitary Anthority and the action taken by the Authority thereon, the annual report should contain a full account.

In making such systematic inspection, as in much of his other action, the Medical Officer of Health will usually have required the assistance of the Inspector of Nuisances; and it will be for the Medical Officer to include in his report an account of the action which, at his instance, the Inspector may have taken for the removal of nuisances injurious to health.

As regards the tabular statements of sickness and mortality only one observation appears to be needful—the district under the superintendence of a Medical Officer of Health will often contain several parts evidently differing in their circumstances, or having very different rates of mortality, either of mortality from all causes, or of mortality from some particular disease or class of diseases. The observation of these differences can scarcely fail to lead to valuable information, and it is in view of such differences that the tabular statements are required in section 14 to be classified according to *localities*, and that provision for such a classification is made in the forms supplied for returns of deaths. In the absence of any ascertained differences of the above sort, it will still be desirable to classify the deaths of the district according to the part of the district in which they occur; and for this purpose any areas of known population (such as parishes, groups of parishes, townships, or wards) may be taken as representing "*localities*" for the purposes of the order. Classification on this basis will be likely to lead to the discovery of real differences when the returns for several years can be compared together.—The same considerations apply to the records of sickness (Table B.). These records should be tabulated for every sanitary district; and it will be well before proceeding to fill the columns and the blank spaces, to note carefully the headings and the footnotes. These records will have particular interest for districts which have a system of "notification" and which have provided themselves with public means for isolating cases of infectious sickness.

What has been said above with regard to the information which an annual report should contain must be understood, not as suggesting that the report should be limited to these subjects, or that more detailed or differently arranged tabular statements may not be added, but as

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Memoranda as to Annual Reports of Medical Officers of Health.

indicating the sort of information required by the Board's order. Many Medical Officers of Health will doubtless, with great advantage to the administration of their district, furnish much more detailed information respecting particular questions to which they have been led by the circumstances of the foregoing year to devote attention, or in the investigation of which they may have arrived at valuable conclusions. Any information of this kind will be appreciated by the Local Government Board.

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Extract from the Order of the Local Government Board, March 1891.

*Duties.*

Art. 18. The following shall be the duties of the Medical Officer of Health in respect of the district for which he is appointed.

(1.) He shall inform himself as far as practicable respecting all influences affecting or threatening to affect injuriously the public health within the district.

(2.) He shall inquire into and ascertain by such means as are at his disposal the causes, origin, and distribution of diseases within the district, and ascertain to what extent the same have depended on conditions capable of removal or mitigation.

(3.) He shall by inspection of the district, both systematically at certain periods, and at intervals as occasion may require, keep himself informed of the conditions injurious to health existing therein.

(4.) He shall be prepared to advise the Sanitary Authority on all matters affecting the health of the district, and on all sanitary points involved in the action of the Sanitary Authority; and in cases requiring it, he shall certify, for the guidance of the Sanitary Authority or of the Justices, as to any matter in respect of which the certificate of a Medical Officer of Health or a medical practitioner is required as the basis or in aid of sanitary action.

(5.) He shall advise the Sanitary Authority on any question relating to health involved in the framing and subsequent working of such byelaws and regulations as they may have power to make, and as to the adoption by the Sanitary Authority of the Infectious Disease (Prevention) Act, 1890, or of any section or sections of such Act.

(6.) On receiving information of the outbreak of any contagious, infectious, or epidemic disease of a dangerous character within the district, he shall visit without delay the spot where the outbreak has occurred, and inquire into the causes and circumstances of such outbreak, and in case he is not satisfied that all due precautions are being taken, he shall advise the persons competent to act as to the measures which may appear to him to be required to prevent the extension of the disease, and take such measures for the prevention of disease as he is legally authorised to take under any statute in force in the district, or by any resolution of the Sanitary Authority.

(7.) Subject to the instructions of the Sanitary Authority, he shall direct or superintend the work of the Inspector of Nuisances in the way and to the extent that the Sanitary Authority shall approve, and on receiving information from the Inspector of Nuisances that his intervention is required in consequence of the existence of any nuisance injurious to health, or of any overcrowding in a house, he shall, as early as practicable, take such steps as he is legally authorised to take under any statute in force in the district, or by any resolution of the Sanitary Authority, as the circumstances of the case may justify and require.

(8.) In any case in which it may appear to him to be necessary or advisable, or in which he shall be so directed by the Sanitary Authority, he shall himself inspect and examine any animal, carcase, meat, poultry, game, flesh, fish, fruit, vegetables, corn, bread, flour, or milk, and any other article to which the provisions of the Public Health Act, 1875, in this behalf shall apply, exposed for sale, or deposited for the purpose of sale or of preparation for sale, and intended for the food of man, which is deemed to be diseased, or unsound, or unwholesome, or unfit for the food of man; and if he finds that such animal or article is diseased, or unsound, or unwholesome, or unfit for the food of man, he shall give such directions as may be necessary for causing the same to be dealt with by a Justice according to the provisions of the statutes applicable to the case.

(9.) He shall perform all the duties imposed upon him by any byelaws and regulations of the Sanitary Authority, duly confirmed where confirmation is legally required, in respect of any matter affecting the public health, and touching which they are authorised to frame byelaws and regulations.

(10.) He shall inquire into any offensive process of trade carried on within the district, and report on the appropriate means for the prevention of any nuisance or injury to health therefrom.

(11.) He shall attend at the office of the Sanitary Authority or at some other appointed place, at such stated times as they may direct.

(12.) He shall from time to time report in writing to the Sanitary Authority his proceedings, and the measures which may require to be adopted for the improvement or protection of the public health in the district. He shall in like manner report with respect to the sickness and mortality within the district, so far as he has been enabled to ascertain the same.

(13.) He shall keep a book or books, to be provided by the Sanitary Authority, in which he shall make an entry of his visits, and notes of his observations and instructions thereon, and also the date and nature of applications made to him, the date and result of the action taken thereon and of any action taken on previous reports; and shall produce such book or books, whenever required, to the Sanitary Authority.

(14.) He shall also make an annual report to the Sanitary Authority, up to the end of December in each year, comprising a summary of the action taken, or which he has advised the Sanitary Authority to take, during the year for preventing the spread of disease, and an account of the sanitary state of his district generally at the end of the year. The report shall also contain an account of the inquiries which he has made as to conditions injurious to health existing in the district, and of the proceedings in which he has taken part or advised under any statute, so far as such proceedings relate to those conditions; and also an account of the supervision exercised by him, or on his advice, for sanitary purposes over places and houses that the Sanitary Authority have power to regulate, with the nature and results of any proceedings which may have been so required and taken in respect of the same during the year. The report shall also record the action taken by him, or on his advice, during the year, in regard to offensive trades, to dairies, cow-sheds, and milk shops, and to factories and workshops. The report shall also contain tabular statements (on forms to be supplied by us, or to the like effect) of the sickness and mortality within the district, classified according to diseases, ages, and localities.

Provided that, if the Medical Officer of Health shall cease to hold office before the thirty-first day of December in any year, he shall make the like report for so much of the year as shall have expired when he ceases to hold office.

(15.) He shall give immediate information to us of any outbreak of dangerous epidemic disease within the district, and shall transmit to us a copy of each annual report and of any special report. He

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shall make a special report to us of the grounds of any advice which he may give to the Sanitary Authority with a view to their requiring the closure of any school or schools, in pursuance of the Code of Regulations approved by the Education Department, and for the time being in force.

(16.) At the same time that he gives information to us of an outbreak of infectious disease or transmits to us a copy of his annual report or of any special report, he shall give the like information or transmit a copy of such report to the county council or county councils of the county or counties within which his district may be situated.

(17.) In matters not specifically provided for in this order, he shall observe and execute any instructions issued by us, and the lawful orders and directions of the Sanitary Authority applicable to his office.

(18.) Whenever we shall make regulations for all or any of the purposes specified in section 134 of the Public Health Act, 1875, and shall declare the regulations so made to be in force within any area comprising the whole or any part of the district, he shall observe such regulations, so far as the same relate to or concern his office.

## No. 24.

MEMORANDUM on the CIRCUMSTANCES under which the CLOSING of PUBLIC ELEMENTARY SCHOOLS or the EXCLUSION therefrom of particular CHILDREN may be required in order to prevent the Spread of Disease. (December 1890.)

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School memorandum.

1. It is attempted in these notes to bring together the information in the possession of the Local Government Board, derived from the reports of the Board's own Medical Inspectors and of local Medical Officers of Health, respecting school-closure and exclusion from school as precautions against infection. It is sought to indicate the best means of preventing the spread of disease by school children among their fellows, while avoiding any unnecessary interruption of the work of education.

Objects of memorandum.

2. In the Code of Regulations approved by the Lords of the Committee of Council on Education, the following Article (Art. 88) prescribes as one of the general conditions required to be fulfilled by a public elementary school in order to obtain an annual Parliamentary grant that—

Regulations of Education Department.

"The managers must at once comply with any notice of the Sanitary Authority of the district in which the school is situated, requiring them for a specified time, with a view to preventing the spread of disease, either to close the school or to exclude any scholars from attendance, but after complying they may appeal to the Department, if they consider the notice to be unreasonable."

3. The diseases for the prevention of which school closure, or the exclusion of particular children, will be required are principally those which spread by infection directly from person to person, such as scarlet fever, measles, diphtheria, whooping-cough, small-pox, and rötheln, the order in which the several diseases are here given being about that of the relative frequency with which their occurrence gives rise to these questions at schools. More rarely, the same questions arise in connexion with enteric fever and diarrhœal diseases which spread not so much by direct infection from person to person as indirectly through the agency of local conditions, such as infected school privies.

Diseases principally requiring action.

4. It will be seen that Article 88 quoted above confers upon sanitary authorities an alternative power with respect to public elementary schools.

(A.) To cause particular scholars to be for a specified time excluded from attendance, or

(B.) To require the school to be closed for a specified time.

5.—*A. First as to exclusion from school of particular scholars.*—Here it will be convenient to consider the circumstances under which the requirements of the public health will be satisfied by the less severe measure of the exclusion from school of particular children.

Exclusion of scholars

(*a.*) It may be laid down as a universal principle that all children suffering from any dangerous infectious disorder (*i.e.*, of a nature dangerous to some of the persons attacked by it, however mild in other cases) should be excluded from school until there is reason to believe that they have ceased to be in an infectious condition (*see* section 126 of the Public Health Act, 1875).

(*b.*) Furthermore, as it is rarely possible to provide effectual separation of the sick from the healthy within the homes of children of the class attending public elementary schools, it must commonly be necessary that all children of an infected household should be excluded from

from infected houses,

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school; first, because otherwise such children might attend school while suffering from the disease in a latent form, or at an unrecognised stage, and, secondly, because it is known that infection may attach itself to, and be conveyed by, the clothes of a person living in an infected atmosphere, even though the person himself remain unaffected. The same considerations will sometimes make it desirable to prohibit the attendance at school of all children from a particular street or hamlet.

from particular localities.

In the case of infectious diseases involving little or no danger to life, such as mumps or skin diseases, school interests may be more particularly considered. In such case, however, the rule of prohibiting the attendance of every child while in an infectious state will commonly prove to be the right one; for if disease should spread to other scholars owing to the continuance of an infected child at the school, there will be greater ultimate loss of attendance with corresponding loss of credit to the school.

Closing of schools:

6.—*B. Secondly, as to the closing of schools.*—This, by more seriously interfering with the educational work of a district, is a much more grave step for a Sanitary Authority to take than to direct the exclusion of particular scholars. It is a measure that seldom ought to be enforced, except in presence of an actual epidemic, nor even then as a matter of routine nor unless there be a clear prospect of preventing the propagation of disease, such as could not be looked for from less comprehensive action.

when to be required.

The mere fact that in an epidemic many of the sufferers are school children does not necessarily show that the disease was caught at school; but the school may with probability be regarded as spreading infection if in a large majority of households attacked the first case be a child attending school; and with still greater probability if a number of children living at a distance from one another, and with no circumstances in common, except that they attend the same school, should be simultaneously attacked, and if it can be ascertained that a child or teacher in an infectious state has actually been attending the school.

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Duty of Medical Officer of Health when infectious disease occurs.

7. The Medical Officer of Health, on becoming aware of the presence of dangerous infectious disease in his district, should, under Articles 2 (7) and 18 (6) of the Board's General Orders prescribing the duties of Medical Officers of Health, send immediate notice to the teacher of the school or schools which the children of infected households may be attending, requesting that such children may be excluded from school for such time as he (the Medical Officer of Health) may specify as being necessary. Ready compliance with such request may often render formal action under Article 88 of the Education Code unnecessary.

Aid which schoolmasters and others can give.

The attention of school attendance officers and of schoolmasters should also be drawn to the following considerations. Frequently they themselves will obtain the earliest information of the occurrence of infectious disease among scholars, and it is most desirable that such officer or master should without delay communicate the facts to the Medical Officer of Health. Absence of any child from school on the plea that it is suffering under one of the before-mentioned diseases, and absence of several children of one family from school at the same time, no matter what name be given to the complaint that keeps them at home, should be reported to the health officer. In practice it has been found that this notification of

absentees has materially aided the local health officer in taking measures for the suppression of infectious disease, to the advantage alike of the district and of the school. Furthermore, schoolmasters may properly be asked to take note, especially when an epidemic threatens or is present, of symptoms occurring in any of their scholars that may indicate the commencement of disease, febrile in nature. Besides heat of skin, such symptoms are shivering, headache, and langour, especially if commencing suddenly, vomiting, rashes on the skin, and sore throat. When scarlet fever or diphtheria is about, every trace of sore throat should be looked upon as suspicious. In any case where such symptoms are observed, the safest course will be to exclude the child from school until assurance can be had that it may attend school without harm to itself or danger to other scholars.

School memorandum.

8. As regards duration of exclusion from school of particular children, the time to be specified will vary in different diseases and different cases, and in this matter the Sanitary Authority will doubtless be guided by the advice of their Medical Officer of Health, who may properly be entrusted with some general duty of acting for the authority in this subject matter.

Exclusion of particular scholars; duration of.

Medical Officers of Health, having to specify a time during which any scholars are to be excluded from attendance at any school, should have regard as far as practicable to the circumstances of the particular scholars suffering from infectious disease or living in infected households. Not only the nature of the infection and the length of illness, but the environments of the individual as affecting the retention of infection will deserve consideration. The period of exclusion, for example, will need to be different according to the conditions of a patient's lodgment, according to the sufficiency of the separation that can be effected between a patient and excluded scholars, and according to the opportunities of effectual disinfection that can be afforded to the household. Thus a hard and fast rule, such as has been laid down in some districts where scarlatina has been present, that no child shall go to school from an infected house for three months after the disease has begun in that house, is not to be commended. It is indeed possible that under the circumstances of a particular household, a child convalescent from scarlatina or living in the same house with convalescents should not in the interests of other children be permitted to return to school until after so long a period as this; but the same ought not to be assumed of all households in the district that may be invaded by scarlatina. The better plan would be for the sanitary authority to secure, during a shorter period, the exclusion of individual sick persons and their housemates from school; and when that period is about to expire to cause fresh inquiry to be made as to the expediency of further exclusion, and, if found requisite in particular cases, to cause fresh notice to be given to the school managers.

Considerations which should determine period.

Period of exclusion may be prolonged by new notice.

9. In deciding whether an outbreak of infectious disease among children of school age may be best combated by closing the school, or whether it will suffice to exclude the children of infected households, the two most important points to be considered are:—

Whether exclusion or school closure to be preferred.

The completeness and promptness of the information received by the officers of the sanitary authority respecting the occurrence of infectious cases.

The opportunities which exist for intercourse between the children of different households elsewhere than at school.

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School memorandum.

When exclusion system to be preferred.

10. The more prompt and full the knowledge of cases of infectious disease that the Sanitary Authority are able to obtain, the better will be the prospect of checking such disease by keeping away from school the children of infected households, and the less will be the necessity for closing schools. If the cases be few in number, and their origin known, the exclusion from school of the children of infected households will probably suffice, but this measure will fail where there are many undiscovered or unrecognised cases, or where the known centres of infection are peculiarly numerous.

When total closure of school preferable.

Commonly, the failure of carefully considered measures of exclusion to stay the spread of an epidemic which shows a special incidence upon school children, may be regarded as pointing to the continued attendance at school of children with the prevalent disease in a mild or unrecognised form, and a strong case will appear for the closing of schools.

If by reason of the absence or exclusion of a large number of children, the attendance at a school be greatly reduced, it may be found better to close it altogether. This is especially apt to occur in the case of epidemics of measles, a disease which is very infectious in the early stages, before the characteristic rash has appeared, and while the symptoms resemble those of a common cold.

Closure of schools

11. The second material consideration, in deciding as to the desirability of closing schools during the prevalence of infectious disease, is the amount of opportunity for intercommunication between the members of different households elsewhere than at school. In

in rural districts,

sparsely populated rural districts, where the children of different households, or of separate hamlets rarely meet except at, or on their way to, the village school, the closing of the school is likely to be effectual in checking the spread of disease. It is less likely to be useful in a town or compact village (particularly where houses are sub-let and yards are in common), where the children of different households, when not at

in populous localities,

school, spend their time in playing together, and often run in and out of each other's houses. In some such places the closing of schools has even appeared to do harm rather than good.

In rural districts, where epidemic diseases are less frequently prevalent, school closing may be required as an exceptional measure to meet an exceptional state of things. As regards more populous places, it must not be forgotten that if schools were to be closed whenever an infectious disease was prevalent, there are many places where schools would hardly ever be open.

for purposes of disinfection, &c.,

It will sometimes be necessary to close a school for a day or two to allow of the rectification of sanitary defects of a nature to extend disease, or in order that the school may be disinfected or purified. It has happened that infectious sickness in the master's family has forbidden the attendance of scholars. These more temporary and occasional closures of schools are contemplated in the Education Code, and are to be regarded as having a real importance of their own.

where many schools exist.

12. In places where there are several public elementary schools, if an outbreak of infectious disease be confined to the scholars of one particular school, it may be sufficient to close that school only. But where different schools have all appeared to aid in the spread of disease (though perhaps to an unequal extent) the sanitary authority may consider it advisable that all should be closed lest children in an infectious state who previously attended the schools that are closed, should be sent to others that might remain open.

School memorandum.

Sunday and private schools.

It must be remembered that sanitary authorities have no power in respect of Sunday schools, or other private schools: except in so far as these may contravene sect. 91 (5), sect. 126, or other provision of the Public Health Act, 1875; but it will often be expedient to invite the co-operation of managers of such schools in efforts for securing the public health. Experience shows that they are usually ready to defer to the representations of the authority responsible for the public health of the district.

Duty of Medical Officer of Health as to reporting.

13. Reports to sanitary authorities, advising the closure of a school or schools in any district, are to be treated as "special" reports within the meaning of the General Order of the Local Government Board of March 1880, and copies of them should accordingly be sent to the Board. These reports should state the grounds upon which the Medical Officer of Health advocates the closure of the school or schools in preference to the exclusion of particular scholars.

Notices requiring closure of schools.

14. All notices of the Sanitary Authority for the closing of Public Elementary Schools should be addressed in writing to the Managers, and should state the grounds on which the closing is deemed necessary.

Notices to specify definite periods.

All such notices should specify a definite time during which the school is to remain closed; this should be as short a period as can be regarded as sufficing on sanitary grounds; a second notice may be given before the expiration of the first, if it should be found necessary to postpone the re-opening of a school. The Managers of schools, after complying with the requirements of the Sanitary Authority, have the right of appeal to the Education Department, if they consider any notice to be unreasonable.

# APPENDIX B.

## No. 1.





### Further Report on the Etiology of Diphtheria; by E. Klein, M.D., F.R.S.

Summary of previous work.

In last year's (1889) report I showed that recently calved cows, inoculated subcutaneously with cultivation of the diphtheria bacillus derived from human diphtheria membrane, become attacked by definite illness, having as one of its manifestations a peculiar acute eruptive affection of the udder; and that from the milk of an animal made ill in this way the diphtheria bacillus could be isolated by cultivation. Further, I showed that my experimental cows had become affected with visceral disease, notably of the lungs, liver, and kidneys. And in that report I stated in detail the conditions under which the above eruptive disease appeared, with my grounds for referring the observed clinical symptoms and pathological appearances of these cows to none but a single cause, namely, to the subcutaneous inoculation of the cows with the diphtheria bacillus.

Objections to inferences therefrom.

Löffler, however, seemed to think (International Medical Congress Berlin, 1890) that the results obtained by me in the cow, as briefly described in May of last year in my communication to the Royal Society, ought to be accepted only with caution. But I do not expect that he will, after reading my full report which has since been published, longer hesitate to accept the conclusions which I have drawn. Nor do I think his doubts with reference to my statement at the Royal Society, as to the disease induced in the cat by subcutaneous and intratracheal injection of diphtheria cultures, will persist when he has had opportunity of seeing the drawings published along with the text of my complete report. Having regard to the strikingly positive and uniform results obtained by me, and described in detail on p. 165 of last year's (1889) report of the Medical Officer, Löffler will probably be able to discern the circumstances that led to his failure to obtain affirmative result after injecting a cat-trachea with cultivation of diphtheria bacillus.

Directions of further experiment.

During 1890–91 I have been employed on matters as follows:— A., further experiments with bacillus diphtheriæ on cows; B., inoculation of this bacillus (cutaneously and subcutaneously) into calves; C., feeding experiments with cultures of this organism on cats; and D., experiments with the bacillus, and with its chemical products, on guinea-pigs. In addition, I have had opportunity of observing what I take to be diphtheria outbreaks among cows and among cats, and I accordingly append accounts of my observations thereon.

App. B. No. 1.

On the Etiology of Diphtheria; by Dr. Klein. Cow-experiment No. 1. (*Sub-cutaneous injection.*)

## A.—Cows inoculated (subcutaneously) with Bacillus Diphtheriæ.

*Experiment* I.—On April 19th, 1890, a cow, No. 3, was inoculated with broth culture of the diphtheria bacillus, derived from cow No. 1 of the previous series (see last year's (1889) report, p. 173), subcutaneously in the left shoulder. At the same time a second cow, No. 4, was inoculated, also in the left shoulder, with an Agar culture of the bacillus also from the tumour of cow No. 1. The broth culture and the Agar culture were each of them seven days old, and had been incubated at 37° C. Both cows had calved about 4–6 weeks previously.

On April 21st, cow No. 3 had a big tumour on left shoulder, tender and soft to the touch. In cow No. 4 a tumour was not visible, but the place of inoculation was very tender.

On April 24th the condition of the cows was much the same; cow No. 4, however, was coughing.

On April 25th both cows were coughing. In cow No. 3 the tumour was easily seen and felt, but in cow No. 4 no tumour was visible, although the place of inoculation was as tender as in cow No. 3. Cow No. 4, however, had conspicuously fallen away in the flanks.

On April 27th the tumour of cow No. 3 had much enlarged, and was very painful to the touch. The animal had by now conspicuously fallen away in the flanks; she moaned, fed but little, did not ruminate, and her milk secretion had almost ceased. At this date there was in cow No. 4 no visible tumour in the muscle of the shoulder, but the place of inoculation could just be felt. This animal was lying down, being unable to stand. It was much fallen away, gave no milk, did not feed or ruminate, and it had much mucous discharge from the nose. Along the spine in the dorsal region on left side, there was seen a small firm tumour, about the size of a filbert. Similar tumours, four in number, were noticed on right side of the spine. They were all subcutaneous and felt a little soft. Temperature was in both animals normal.

On April 28th both cows seemed a little better. Cow No. 4 fed and ruminated a little. Its temperature was now raised (see table in footnote).

On April 29th, the 11th day of experiment, cow No. 4 died at 4 a.m. *Post-mortem.*—On incision through the skin, at the site of inoculation on the left shoulder, extensive hæmorrhagic infiltration of the subcutaneous and muscular tissue was exposed. This extended over the neck and thorax, where the muscles were permeated by hæmorrhagic

Temperatures of Cows Nos. 3 and 4.

| Date in 1890. | Temperature, in Degrees Centigrade, of— | | | | Date in 1890. | Temperature, in Degrees Centigrade, of— | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Cow No. 3. | | Cow No. 4. | | | Cow No. 3. | | Cow No. 4. | |
| | A.M. | P.M. | A.M. | P.M. | | A.M. | P.M. | A.M. | P.M. |
| April 19 - | 38·8 | 39·0 | 38·6 | 39·2 | April 29 - | 38·4 | 38·8 | 37·2 | Died. |
| „ 21 - | 39·4 | 39·0 | 39·2 | 39·2 | „ 30 - | 39·0 | 39·4 | | |
| „ 22 - | 39·2 | 39·6 | 39·0 | 39·4 | May 1 - | 39·2 | 39·4 | | |
| „ 23 - | 38·8 | 39·1 | 38·6 | 39·2 | „ 2 - | 39·4 | 39·1 | | |
| „ 24 - | 38·8 | 39·4 | 39·0 | 39·0 | „ 3 - | 39·0 | 39·0 | | |
| „ 25 - | 39.0 | 39·0 | 38·6 | 38·8 | „ 5 - | Found dead. | — | | |
| „ 26 - | 38·8 | 39·0 | 38·4 | 38·6 | | | | | |
| „ 28 - | 39·2 | 39·0 | 39·0 | 39·0 | | | | | |

necrotic tissue, which when cut into exuded much sanguineous œdematous fluid. Both *lungs* were very œdematous, the upper lobes and the upper part of the next lobes congested; the *pleural lymphatics* were well marked and distended by clear lymph; the visceral *pericardium* over the left, and particularly over the right, ventricle of the heart, showed numerous hæmorrhages in the form of petechiæ in lines and in patches; a condition similar to that described and figured in last year's (1889) report, pp. 172 and 173, and figures 68, 69, and 72. On the surface of the *liver* were noticed a few necrotic brown patches. Both *kidneys* were in the condition known as white kidney, the cortex of each being in a state of fatty degeneration.

On May 3rd cow No. 3 appeared again quiet. She did not feed at all; her temperature, however, was not raised. The tumour on her left shoulder could be felt as a well-defined firm swelling. This animal was found dead in the morning of May 5th, the seventeenth day of experiment. *Post-mortem.*—On incision into the skin over the left shoulder extensive hæmorrhagic infiltration was exposed, extending through the subcutaneous and muscular tissue of neck and thorax. In the muscle in the region of the left shoulder numerous necrotic septa were noticed, along with much œdema. The upper lobes of both *lungs*, and the upper part of the next lobes, were œdematous and congested. The pleural *lymphatics* were distended with sanguineous lymph. The tracheal mucous membrane was uniformly and deeply congested; in it were noticed hæmorrhagic patches, and the same deep congestion was observed of the mucous membrane lining the large bronchi; which also contained bloodstained mucus. The visceral *pericardium* showed hæmorrhagic spots and patches. The bronchial *lymph glands* were swollen, œdematous, and dark red. The wall of the *gall bladder* was œdematous, and in its membrane were numerous gas bubbles; its lymphatics were conspicuous from being distended. Within it was abundance of bile. Both *kidneys* showed in the cortex patches of grey fatty tissue.

From the hæmorrhagic necrotic muscular tissue of the shoulder region of both cows (Nos. 3 and 4), gelatine and Agar tubes were inoculated, and pure cultivations of the diphtheria bacillus were obtained. In neither cow were any diphtheria bacilli demonstrable by cultivation from the heart's blood, or from lung, liver, or spleen.

In neither cow be it noted was there observed at any time any abnormal condition of the skin of the teats or udder. Milk too taken from the cows on April 26th, *i.e.*, on the eighth day after inoculation, was examined by the culture test, but no diphtheria colonies were obtained.

From these two experiments it is seen that the bacillus diphtheriæ derived from the local tumour of cow No. 1 produced in other cows intense pathogenic action; action fully as virulent as that of the bacillus derived from human diphtheria membrane which was used in previous (1889) experiments for inoculation of cows Nos. 1 and 2. The local inoculation effects, and the visceral disease produced in cows Nos. 3 and 4 were moreover identical with those produced in cows Nos. 1 and 2. Nevertheless cows Nos. 3 and 4 showed no disease of the udder, and diphtheria bacilli were not found in their milk at a date subsequent to inoculation corresponding to that at which the milk of cow No. 2 of last year's experiments had been discovered to contain the diphtheria organism.

Cow-experiment No. 2. (*Sub-cutaneous injection.*)

*Experiment* II.—In this experiment I used for inoculation of two additional cows, Agar culture in which the bacilli had lost somewhat of their virulence. The cultures used in previous experiments, namely, those

on the cows of 1889, and those on cows Nos. 3 and 4 of this series, *when tested by concurrent inoculation into guinea-pigs*,* had been found to be virulent; small quantities ($\frac{1}{4}$ c.c.) of them inoculated in the subcutaneous tissue of these animals having produced the characteristic œdematous hæmorrhagic tumour in 24 hours, and death in between 36 and 48 hours. But the culture used in the present instance (for cows Nos. 5 and 6) did not show the same virulence. It was a culture on Agar, five days old, derived originally from human diphtheria. And as I have already mentioned in last year's (1889) report, and have since experienced several times during this year's investigations, diphtheria bacilli grown on Agar cannot always be relied on for virulence. Gelatine cultures are in this respect always much more certain.

From the Agar subculture in question a salt mixture was made; a particle of the culture being distributed in a few c.c. of sterile salt solution so as to render the mixture slightly turbid. On June 6th a Pravaz syringeful of this mixture was injected subcutaneously in the left shoulder of two cows, Nos. 5 and 6. At the same time six guinea-pigs were inoculated therewith, of which only three died, while other three survived, thus showing that the culture used was not of the usual virulence.

On June 7th there was to be felt a slight swelling over the left shoulder of each cow; but otherwise the animals were perfectly normal.

On June 9th the swelling was still to be felt, but there was no tenderness.

On June 12th a firm swelling about the size of a filbert could be felt under the skin of left shoulder of each cow.

On June 15th no tumours could be felt.

On June 20th the animals seemed perfectly right both as regarded local and general condition.

Cow-experiment No. 3. (*Sub-cutaneous injection.*)

*Experiment* III.—On June 24th both cows (Nos. 5 and 6) were again inoculated, this time with a broth culture (seven days old) of diphtheria bacillus from a human source. A Pravaz syringeful of this culture was injected into the subcutaneous tissue of the right shoulder of each animal.

On June 25th both animals were quiet and off their feed. A slight swelling could be felt on the right shoulder of each; temperature 41° C.

On June 25th the swellings over their right shoulders could be distinctly seen; the skin here was very tender, and the animals were still off their food.

On June 27th the tumours were still visible, but the animals fed a little better.

On June 30th the tumours in the regions of their right shoulders were firmer, of about the size of a fist each; the epidermis over the swellings desquamating in large flakes. The animals looked fallen away in the flanks, and coughed.

On July 1st conditions much the same.

On July 4th the tumours were firmer and smaller; the animals looked still fallen in and coughed a good deal.

On July 10th both animals were getting very thin; their tumours were still easily felt and were firm. Both cows were now killed.

On *post-mortem* examination there was found in both of them the same conditions as regards local tumour (viz., necrotic septa pervading the muscular and subcutaneous tissue), and as regards the lungs and visceral pericardium, the lesions that were manifested in cows Nos. 1, 2, 3, and 4. The cortex of their kidneys too showed patches of grey fatty tissue, but this condition was less pronounced than in cows Nos. 3 and 4.

* I shall have presently to insist (pp. 231–34) upon the importance of this test as determining "virulence" in diphtheria cultures.

Cultivations made of the necrotic tissue of the tumours yielded pure cultivations of the diphtheria bacillus, but the colonies that came up were only very few indeed. At no time was there any abnormal condition noticed on the teats or udders of these two cows. And further, milk taken from a clean teat on the eighth day after inoculation in the case of cow No. 5, and on the twelfth day in the case of cow No. 6, did not, in 14 tubes inoculated therewith, yield a single colony of the diphtheria bacillus during four weeks' incubation.

We learn from these experiments that the result of using less virulent culture for inoculation of cows is, as indicated by the local swelling, very slight, and that cows thus dealt with remain susceptible to a further inoculation if virulent cultures be used. And this is quite consistent with the behaviour under like circumstances of guinea-pigs; for if a first inoculation of these animals with very small doses of virulent, or with ordinary dose of attenuated culture, have but slight and transient result, re-inoculation of them with ordinary dose of virulent culture will develop the local swelling which is typical of diphtheria disease in the guinea-pig.

Cow-experiment No. 4. (*Sub-cutaneous injection.*)

*Experiment* IV.—On January 27th, 1891, two milch cows, Nos. 7 and 8, were inoculated subcutaneously in the tissue of their left shoulders, each receiving one syringeful of a broth subculture of human diphtheria bacillus. This broth culture was only five days old; but the contained bacillus had been originally derived from a case of acute diphtheria in January 1890, and had passed through many series of subculture during the succeeding twelve months.

On January 29th, in both animals a soft tender swelling could be felt on the left shoulder.

On January 31st a tumour in cow No. 7 was visible at the site of inoculation. In cow No. 8 no tumour was visible to the eye, perhaps because diffuse; but definite swelling all about the shoulder could be felt.

On February 1st there was noticed in cow No. 7 at the base of the left hind teat a small round flat ulcer, covered with a thin brown scab. This ulcer was about $\frac{1}{8}$ of an inch in diameter, and to the finger the skin around it felt distinctly indurated. No other teat showed anything abnormal.

On February 2nd the scab of the ulcer on the teat of cow No. 7 had become detached, and the ulcer seemed healing. But near to it were now observed two other ulcers, or rather pustules, covered with a thin brownish crust. These pustules were round and measured each about $\frac{1}{8}$ of an inch in diameter. No other eruption was noticed on the udder or teats of this cow No. 7, and the sores observed there had died off and had quite healed by February the 5th.

At this time cow No. 8 showed nothing abnormal on the udder or teats.

About February 18th (23rd day) it was noticed that both cows, particularly cow No. 8, had gradually developed loss of hair over extensive parts of the face, neck, and haunches. On that day too there was observed for the first time on the udder of cow No. 8, between and about the teats, an eruption of small round pimples and pustules surrounded by injected skin. The size of the pimples was about $\frac{1}{8}$ of an inch, that of the pustules, which were round, about $\frac{1}{6}$ of an inch. Some of the pustules showed on their surfaces thin brown crusts.

On February 19th several fresh pimples were noticed on the udder of cow No. 8; all the pustules of the day before having by this time become covered with brown crusts.

On February 20th one of the sores had become about $\frac{1}{4}$ inch in diameter; it was round and covered with thick brownish black crust. The skin underneath appeared much indurated.

On February 21st no new eruption had developed on udder of cow No. 8. Some of the crusts had by now become loose and were falling off; the ulcers beneath were healing.

On February 23rd all the sores of cow No. 8, except the big one above mentioned, had almost healed. But several new pustules were now noticed.

On February 28th all the above sores had healed, but there was one fresh pustule beneath which the skin was much indurated.

On March 3rd the above pustule had become a round sore about $\frac{1}{4}$ inch in diameter, and was covered with a brownish black crust.

On March 6th the scab had become detached, and the sore itself was almost healed. After this there appeared no more eruption.

The condition ofboth cows Nos. 7 and 8 remained all this time very good. The animals fed well, their temperature was normal, and they gave ample milk. The swellings on their shoulders had by the end of February so much decreased that in one cow, No. 8, it could hardly be felt; while in the other cow, No. 7, it was just possible to feel but not to see that there was slight induration in the subcutaneous tissue there.

We have then, in cow No. 8, as regards her udder, a very conspicuous positive result; a result in all respects analogous to that which was obtained in 1889 with cows Nos. 1 and 2, with the exception only that in the present instance the cutaneous eruption appeared rather late, *i.e.*, was not noticed until the end of the third week. But in this connexion I ought to state that the inspections of the udder was in these cows beset with great difficulties. In the first place I was prevented from personally examining these animals during the first three weeks of February; my assistant had to do it for me. And in the second place the exceptionally dark days of February were not favourable for satisfactory inspection of the udders which in the particular animals were covered with thick hairs. Thirdly, the eruption was small and situated at the lower part of the udder, so that it was liable to be easily overlooked. As a matter of fact on the first day that I was able personally to examine cows Nos. 7 and 8, namely, on February 18th, I felt carefully the surface of the udder, and my attention was at once arrested by a pimple with indurated cutis at the base of the udder. Hereupon I had the cow thrown, and on careful inspection, inclusive of cutting off the hairs between and about the teats, found the several pimples and pustules above mentioned. I must therefore be understood to say that though the eruption had not been noticed before the end of the third week after inoculation, some of the eruption may have appeared, and even have disappeared, before date. In cows Nos. 1 and 2 be it remembered (see Report for 1889, pp. 169–70), the eruption continued to appear for some days.

Precisely the same qualification must be extended to my account of cow No. 7. How long after the first ulcer had healed, *i.e.*, after February 5th, the udder remained free of eruption, I am not in a position to say for the reasons above stated.

On February 20th when the eruption was well developed on cow No. 8, milk was drawn from one of her teats, precautions being taken as in former experiments against introduction during the process of extraneous organisms. The teat to be milked (a sound one) was thoroughly rubbed over with soap and well washed also with warm water. Then it was rubbed with cotton wool steeped in 10 p.c. carbolic solution. The milker s hands were scrubbed clean; next washed with

soap and water, and then in 10 p.c. carbolic solution. A clean beaker having been sterilised over the flame (and until brought into use covered with clean glass plate) was made to receive the third and subsequent strokes of milk induced by the milker. The beaker was then immediately covered up again with the glass plate and carried into the laboratory, where the inoculation of suitable nutritive media with samples of the milk was proceeded with. Gelatine and Agar in tubes was used for this purpose, each tube receiving about $\frac{1}{16}$–$\frac{1}{8}$ c.c. of the milk.

From the milk thus taken from cow No. 8 on February 20th, there were obtained on culture numerous colonies. In four Agar tubes incubated at 37° C. there appeared by the fourth day 4–8 colonies in each of a growth which on naked eye inspection, and under a magnifying glass, looked uncommonly like the diphtheria bacillus. Other seven tubes remained sterile, and a twelfth tube showed a colony which proved to be bacillus subtilis. Plate cultivations of the same milk made at the same time on Agar also revealed several colonies of an organism like the diphtheria bacillus. On microscopic examination indeed in the fresh state, as well as after drying and staining a thin film of growth, the characters presented were identical with the diphtheria bacillus. In Plate III., Fig. 12 shows these colonies, and Fig. 11 a streak culture of this bacillus. The appearance of this bacillus in dried and stained cover-glass specimens, is well shown in Figs. 1 and 2, Plate I., where are observed forms strikingly like those of the typical diphtheria bacillus. Nevertheless further cultivations, and particularly cultivations in broth and on gelatine, as well as experiments on guinea-pigs, proved conclusively that this organism was not the diphtheria bacillus. Nor was it the morphologically allied pseudo-diphtheria bacillus.

The bacillus obtained from the milk of cow No. 8 on February 20th, grows much faster on gelatine than the diphtheria bacillus. And both on Agar and on gelatine the separate colonies (in streak culture the aggregated colonies) assume after several days (best seen when viewed in reflected light) a distinctly yellow colour. This is the more striking the older the culture and the thicker the colony or the streak under examination. Moreover cultivated in broth, the bacillus in question does not produce the uniform turbidity that the diphtheria bacillus does; the broth remains clear while the growth proceeds in the depth of the fluid in the form of granules and flakes. And finally, when inoculated subcutaneously into guinea-pigs, this bacillus produces no result.

On February 23rd milk was again taken from the same teat of cow No. 8 as was drawn from on February 20th, and with the same precautions. At the same time milk was also taken from cow No. 7 for inoculation of culture tubes. As a result every one of the tubes now inoculated with the milk of cow No. 7 developed numerous colonies of staphylococcus aureus,* but no other organisms; whereas every one of the tubes inoculated with milk of cow No. 8 now developed colonies of the true diphtheria bacillus. In each tube there appeared 5–10 colonies in the streak marking the course of the drops of milk as they had flowed down the surface of the nutritiv emedium (see Fig. 10, Plate III.). In one tube only was there one colony of stapylococcus aureus in addition to the bacillus diphtheriæ. Fig. 3, Plate I., and Figs. 4 and 5, Plate II., show the diphtheria bacilli in dried and stained cover-glass specimens. By subcultures from the above colonies in various media,

* Presence of the staphylococcus in this milk does not, of course, call in question the efficacy of the precautions adopted in taking the sample. The organism was derived, I have no doubt, from the milk ducts, not superadded to the milk after withdrawal from the teat.

it was conclusively demonstrable that the bacilli now in question were the true diphtheria bacilli.

On March 3rd milk from cow No. 8 was again examined, the sample being taken from the same teat as before. At this date there was still a sore on the udder (see previous page). Out of eight tubes inoculated with this milk, two showed growth of bacillus subtilis and four remained sterile. The other two of the eight tubes showed colonies of the diphtheria bacillus, one of them presenting two, the other four, colonies. In that containing two colonies there appeared also one colony of a liquefying coccus. Subcultures in various media with microscopic examination of samples of the resulting growths, proved the bacillus in question to be the true diphtheria bacillus. Morphologically they corresponded exactly therewith, both as regards the club-shaped forms and forms with segregated protoplasm ; in the matter of size alone they differed, being smaller than the diphtheria bacillus from a human source.

On March 6th and 9th milk was again taken for cultivation, but no diphtheria colonies could be obtained.

Cow No. 8 then, be it observed, presents a complete parallel to cow No. 2 of last year's experiments, inasmuch as during the presence of the eruption on the udder, the milk secreted by this cow revealed on cultivation the presence of the diphtheria bacillus.

By the end of March cows Nos. 7 and 8 showed no longer any abnormal symptoms. The condition of the left shoulder, the skin of the udder, the viscera (so far as could be judged of by physical examination), the quantity of milk secreted, and the feeding and the temperatures of the animals, were in all respects normal. They therefore were considered completely recovered, and were discarded.

Cow-experiment No. 5. (*Feeding.*)

*Experiment* V.—Two milch cows, Nos. 9 and 10, were *fed* on February 27th with broth culture (one week old) of the human diphtheria bacillus ; that is to say, the culture was poured into their throats and swallowed by them. No change of any kind was noticeable in these cows during the four following weeks.

(*Injection.*)

On March 26th, therefore, these same cows (Nos. 9 and 10) were inoculated subcutaneously in left shoulder with broth culture (48 hours old) of the human diphtheria bacillus, one Pravaz syringeful being used in each instance. After 48 hours a swelling was noticed in the region of inoculation in both animals. This swelling was of the nature of œdema, but painful when pressed. During the next four days the swellings became distinct (though they always remained of a diffuse character), and were less painful. In cow No. 9 these symptoms were more pronounced than in cow No. 10.

About the eighth day there was noticed in cow No. 9, at the base of right fore teat, a round pustule, about the size of a sixpence, covered with thin brown crust. Near it, but also at base of teat, was a small indurated nodule of the skin similarly covered with a brown crust. (*See* Plate IV.)

Cow No. 10 was, at this date, free of any eruption on udder or teats.

Both animals, however, seemed to show already a great deal of loss of hair in extensive patches.

Each cow had with her a suckling calf. On the ninth day of its mother's inoculation, the calf of cow No. 9 showed, in the middle of its upper lip, a round, slightly raised patch about the size of a sixpence. The central part of this patch was pale, the marginal part red, and here there was indication of vesiculation (Fig. 1, Plate V.). The calf of cow No. 10 presented, at the same date, a similar patch in the middle of its upper lip. Both these calves, it should be stated, had been, like their

mothers under observation for nearly five weeks, but nothing abnormal had hitherto been noticed on them.

On the seventh day of its appearance the above patch in the calf of cow No. 9 had increased to nearly the size of a shilling, and five other similar patches had become manifest in its neighbourhood. These other patches were round, but much smaller ($\frac{1}{8}$–$\frac{1}{4}$ inch in diameter), than the first. They, too, were a little paler at their centre than at their marginal part, and the latter showed indication of vesiculation. (See Fig. 2, Plate V.)

On its tenth day the large patch above mentioned was unchanged, except that its margin was redder. As to the others, two had much diminished and had nearly disappeared.

On its twelfth day the large ulcer was diminishing, and had become paler. Three small ones were still visible.

By the sixteenth day the large ulcer had almost disappeared, the small ones had meanwhile completely healed up and disappeared.

On the tenth day of inoculation of these cows—*i.e.*, on the day subsequent to appearance of eruption on the lips of their calves—milk drawn from the teats of the cows was inoculated on Agar and gelatine in test tubes. All the Agar tubes inoculated with milk of cow No. 9 were, after three days, crowded with a growth proved to be bacillus subtilis, and all the Agar tubes inoculated with milk of cow No. 10 were, in like time, crowded with colonies of staphylococcus aureus.

## B.—Calves inoculated, cutaneously and subcutaneously, with Bacillus Diphtheriæ.

Calf-experiment No. 1. (*Cutaneous inoculation.*)

(*a.*) *Cutaneous Inoculation of Calves.—Experiment* VI.—On May 24th, 1890, two calves, Nos. 11 and 12, were cutaneously inoculated by incisions (38 in each instance) in the groin and on the belly, with a gelatine subculture (18 days old) of human diphtheria bacillus.

On May 27th all the incisions in calf No. 11 had taken. Each incision was slightly tumid, and redness around it was pronounced. Along the margin of many incisions there was indication of vesiculation, the central portion of each incision being occupied by a lineal thin scab. In calf No. 12 about 30 of the 38 incisions had taken in similar fashion.

On May 28th vesiculation and redness of the incisions had decreased, the median scabs had meanwhile become broader and thicker.

On May 29th loosening of the scabs had commenced, and ulcers underneath were beginning to contract and to become dry.

On May 31st all the scabs were loose, some had fallen off; the ulcers were contracted and healing.

On June 6th reddish cicatrices only remained.

Calf-experiment No. 2. (*Cutaneous inoculation.*)

*Experiment* VII.—On March 4th, 1891, calf No. 13 was cutaneously inoculated in about 30 incisions in the groin and on the belly, fresh human diphtheria membrane (from the fauces) being used for the purpose.

On March 6th all the incisions were raised and red; some showed marginal vesiculation, the contained matter of which appeared purulent.

On March 7th most of the incisions were still raised and red; in some purulent vesiculation was still to be recognised, in others it had been succeeded by thick brown scabs.

On March 8th redness and vesiculation still conspicuous in some incisions; in all the middle line now occupied by brown crust.

On March 9th each incision was completely covered by a thick brown crust. This crust having been removed, an ulcer was exposed.

On March 11th the ulcers were contracting, and some of the scabs had become loose.

On March 13th most of the incisions had become free of scabs.

Calf-experiment No. 3. (*Cutaneous-inoculation.*)

*Experiment* VIII.—On March 6th calf No. 14 was cutaneously inoculated in about 30 incisions with fresh diphtheria membrane from the same case as calf No. 13.

On March 8th first indication manifested of swelling and redness of the incisions; some of them showing marginal vesiculation.

On March 9th swelling and redness and marginal vesiculation, more pronounced; purulent matter in the vesications of some incisions, linear scab well marked in all.

On March 11th all incisions were covered with thick broad brown scabs; some of them becoming loose.

Calf-experiment No. 4. (*Cutaneous inoculation*).

*Experiment* IX.—On March 7th calves Nos. 15 and 16 were cutaneously inoculated each in about 30 incisions (in groin and on abdomen) with fresh diphtheria membrane from the same case as the previous calves.

On March 9th all incisions were raised and red, and some showed distinct marginal vesiculation.

On March 11th all incisions were covered with brown crust, and redness had receded. Some of the crusts were loosening.

From these experiments it appears that by cutaneous inoculation of calves with actual diphtheria membrane, a slight positive result is producible, namely, swelling and redness, with distinct marginal vesiculation by the third day. This might be thought of as due to irritating agents in the diphtheria membrane independent of contained diphtheria bacilli, but for a like result having been produced in calves Nos. 11 and 12 by cutaneous inoculation of pure culture of diphtheria bacillus alone. There can be no doubt, then, that a definite cutaneous effect is producible in calves by inoculation of the diphtheria bacillus itself; an effect which though of short duration was fully pronounced,—at its acme on the fourth day, and passing off again in the course of a week or 10 days.

Calf-experiment No. 5. (*Subcutaneous injection.*)

(*b.*) *Subcutaneous Inoculation of Calves.—Experiment* X.—On June 6th, 1891, a calf, No. 17, was inoculated subcutaneously in the tissue of the groin with an Agar culture of the diphtheria bacillus from a human source. [As before, a particle of the culture was mixed with sterile salt solution, so as to make a turbid mixture, which was injected by a Pravaz syringe.] This Agar culture was the attenuated culture used for inoculation of cows Nos. 5 and 6 (see page 222).

On June 9th there was noticed for the first time in this calf a swollen gland in the groin at the seat of inoculation; the animal was otherwise perfectly normal.

On June 13th the swollen gland felt firmer, but was tender.

On June 15th the swollen gland had greatly diminished, so much so that not much difference was noticed on comparing the two groins.

Having regard to the observed small virulence of the Agar culture now in question when employed upon cows Nos. 5 and 6 (as also when employed upon guinea-pigs) the very insignificant result obtained by use of it on calf No. 17 was not matter for surprise. And accordingly, Calf No. 17 was, on June 24th, reinoculated (as before subcutaneously in the right groin) with the virulent broth culture of the diphtheria bacillus that was employed on that day for reinoculation of cows Nos. 5 and 6.

On June 25th calf No. 17 was quiet, off its food, and a large soft and tender swelling was noticed in its right groin.

On June 26th, this calf was still off its food, was quiet and breathing rapidly. The swelling in its right groin was by now very conspicuous to the eye; it extended over the whole of the scrotum and part of the abdomen. As before it was soft but tender.

On June 27th the swelling had a little decreased, and the animal fed better.

On June 30th the swelling was still distinct, and *the epidermis was found to be desquamating over the swelling in large flakes.*

On July 2nd the swelling was still distinct, but the animal fed well.

On July 10th the tumour in the right groin could still be felt, and was firm; but the swelling of the belly and scrotum had disappeared.

This experiment suffices to show that *subcutaneous* inoculation with virulent diphtheria culture is in the calf, as in the cow, productive of a positive result. The effects in this calf were, however, less severe than in the milch cows.

With a view of testing the diphtheritic nature of the local malady set up in calf No. 17, fluid for experimental purposes was obtained from the depth of the tumour in its groin. And in this way:—The surface of the tumour having been duly washed with disinfectant solution, an incision was made with a sterilised scalpel through the skin covering it, and the pointed end of a capillary pipette plunged into its substance. By a little squeezing of the tumour, fluid therefrom was made to enter the pipette sufficient in quantity for making cover-glass specimens, and for establishing cultures. As a result the presence in the tumour of the diphtheria bacillus was demonstrated by both methods.

In bringing to a conclusion my account of these experiments on diphtheria in relation to the bovine animal, I would add a few words as to the "keeping qualities" of the diphtheria bacillus from a bovine source. In the spring of 1890 I put aside a considerable number of cultures (in tubes) of the bacillus diphtheriæ obtained from the tumours of the shoulders of cows Nos. 1, 2, 3, and 4. These cultures were gelatine cultures, and the tubes containing them I sealed with gutta-percha paper, and kept them in a box in the laboratory for over 10 months. Nevertheless subcultures started from these tubes after this interval proved all of them successful. Hence it appears that diphtheria bacilli from the cow grown on gelatine are capable of retaining their vitality and virulence, at ordinary temperatures, for 10 months, in just the same way that, under like circumstances, this bacillus when derived from a human source will do.

### C.—Feeding Experiments on Cats.

Cat-experiments Nos. 1 & 2. (*feeding.*)

*Experiment* XI.—On May 6th, 1890, one kitten and two cats were fed with recent Agar culture of diphtheria bacillus distributed in milk. The animals remained well, and showed no abnormal symptom.

*Experiment* XII.—On June 14th two additional cats were fed with a culture of diphtheria bacillus in milk, which had been incubated for nine days at 37° C.

On June 16th one of these cats was off her food, and seemed quiet; the other was all right.

On June 17th their state remained the same.

On June 19th one cat was still quiet, and was now sneezing and coughing; the other animal remained all right.

On June 20th the cat that had been indisposed was livelier again and seemed well.

Both were this day (June 20th) fed with gelatine culture of the diphtheria bacillus diffused in warm milk.

On June 23rd they were again fed with diphtheria gelatine culture of diphtheria bacillus diffused in milk. At this date both cats looked all right. But in the evening of the same day both were sick.

On June 24th both cats were quiet and off their food.

On June 25th both cats markedly quiet; one sneezed a good deal.

On June 26th the cats still quiet and off their food.

On June 27th they were in the same state, but both were now observed to be getting very thin; they, however, fed a little.

On July 2nd both cats were quiet and sneezed a good deal; one was by now very emaciated.

On July 4th one cat was extremely thin and weak; could hardly walk, and coughed a good deal. This animal was now killed:—*Post-mortem*. Both *lungs* showed patches of grey consolidation; the *liver* was much enlarged. On its surface and in its tissue were noted numerous blackish-brown patches and spots due to stasis and coagulation of blood in the capillaries; in most parts of the *liver* the acini were fattily degenerated and whitish yellow; both *kidneys* were large, the cortex white.

By July 11th the other cat, though very thin, did not otherwise show much change. It was now killed and presented post-mortem appearances as follows:—Both *lungs* normal; the *kidneys* not conspicuously large, but their cortex pale, with a few whitish patches. The *liver* was greatly enlarged in its substance, and on its surface were numerous dark brown spots and patches, the tissue of the liver acini appearing uniformly and everywhere yellow from fatty degeneration. Microscopic specimens of the liver tissue showed fatty degeneration of the liver cells almost all through the acini, with the exception of those parts next the portal canals.

From this experiment it is seen that by *repeated* feeding with cultures of diphtheria bacillus distributed in milk, unquestionable diphtheria disease can be produced in the cat. That Löffler did not succeed in getting any result in a particular kitten is not surprising. I too similarly failed in Experiment XI. when using Agar culture of the bacillus for a *single* feeding. Possibly my failure in this respect may have been due to the circumstance that the feeding was not repeated; but I am disposed to regard it as due rather to lack of virulence of the culture employed. And I suspect that similar lack of virulence was responsible for the negative result obtained by Löffler on the occasion of his injecting diphtheria culture into the trachea of cats. In my experience it is essential for successful infection in this way of cats, that recent broth culture of the diphtheria bacillus of virulent sort (ascertained by previous or concurrent subcutaneous inoculation therewith of guinea-pigs) be employed, half-to-one syringeful of such culture being injected within the trachea. However this may be, I fail to see how a negative result in this matter obtained by one person can be thought of as outweighing, or even as balancing, the very positive results obtained by another; and as regards the positive results obtained by myself in this connexion I would refer the reader (and Löffler) to the report of the Medical Officer for 1889, pages 165–66. And once again I must insist that in all experiments with cultures of diphtheria bacilli, the virulence of the culture should be tested first (or concurrently) on guinea-pigs. A truly virulent culture, as for instance a broth culture 2–8 days old incubated at 37° C., when $\frac{1}{4}$–$\frac{1}{2}$ c.c. thereof is inoculated into the groin of a guinea-pig, should promptly produce distinct swelling there, and death of the animal in from 1–3 days.

## D.—Experiments on Guinea-Pigs.

Drs. Roux and Yersin in their various publications (Annales de l'Institut Pasteur) have shown that diphtheria bacilli in broth culture form there chemical poisons which when separately injected in sufficient dose into guinea-pigs produce death of that animal in the same manner as the living bacilli of the culture would have done. They have further stated that by injecting small doses of the chemical poison in question, the guinea-pig, though made ill, survives the experiment and becomes thereby protected against what is customarily a fatal dose.

Brieger and Fraenkel (Berlin, Klin. Wochenschrift N. 49) have published important observations on the chemical products of the diphtheria bacillus, having isolated toxins (toxalbumins) from cultivations of this organism.

With reference to diverse effect of different cultures of the bacillus when inoculated into guinea-pigs, these observers state that if cultures of the diphtheria bacilli attenuated by incubation at high temperature or by addition to the culture medium of disinfectants, are used for inoculation of guinea-pigs, these animals will, according to the degree of attenuation of the culture employed, survive the inoculation for days, weeks, or even months. But they further state that if such animals are afterwards tested by inoculation with virulent culture, all will succumb. Thus they obtained no evidence that the guinea-pigs had by means of the first inoculation acquired any ability whatever of resisting inoculation with virulent culture.

When, however, they used for a primary inoculation of guinea-pigs *sterilised* diphtheria culture a certain resistance was demonstrable, in that though a second inoculation of the animal with virulent bacilli proved fatal, death was delayed until lapse of 3, 4, 6, or even 9 days.

Having ascertained this effect of sterilised culture of bacillus diphtheriæ, Brieger and Fraenkel proceeded to use for a first injection 10 c.c. of a broth culture of the bacillus that had been heated at 100° C. for one hour. Guinea-pigs thus treated showed a certain resistance against a further inoculation with virulent culture ; a few animals altogether survived, and in others death was delayed as long as two weeks and a half.

Brieger and Fraenkel next went on to ascertain that inoculation into the guinea-pig of 10–20 c.c. of a three weeks' old broth culture of the bacillus that had been subjected for one hour to 60°–70° C., protects these animals against a further inoculation, provided always the further inoculation with virulent culture be not made within 14 days of the first inoculation.

I myself have made a number of experiments on guinea-pigs with reference to the question of obtaining for them a protection against diphtheria disease. These experiments have differed from those just mentioned in that my object has been to modify, restrain, or inhibit diphtheria malady after it has been set up in these animals ; nevertheless my results are of a sort to confirm those of Brieger and Fraenkel. But before I go further I would insist once again on need for obtaining accurate measure of the virulence of every diphtheria culture to be used upon guinea-pigs ; unless this be done confusion of result is very apt to arise. Cultures of diphtheria bacilli lose a good deal of virulence as time passes, especially Agar cultures (gelatine cultures have been found virulent even after keeping for several months) ; so that in order to obtain acute and virulent effects on guinea-pigs it is important that recent cultures be used ; cultures, that is, which when inoculated

subcutaneously in sufficient dose produce swelling (hæmorrhagic and œdematous infiltration of the tissues) at the seat of inoculation, and death of the guinea-pig in 1–3 days. If the culture employed be not virulent, death is delayed according to the degree of attenuation; the animals, it is true, all show a tumour at the site of inoculation, which after several days can be felt as a firm swelling; but they do not die for several additional days, sometimes not until after several weeks. But whatever the result of inoculation, whether acute or chronic malady be induced, I have with very few exceptions succeeded in obtaining good cultures of bacillus diphtheriæ from the local tumour. Dr. Hamer will in another paper describe the distribution and relations of the bacilli in the diphtheria-tumours of experimental guinea-pigs in which death was considerably delayed. I do not, therefore, enter here into this part of the subject. But it needs to be stated that when virulent culture is desired a *broth subculture* should be made—the source whence it is derived, whether virulent or attenuated, being matter of indifference—and this subculture should be incubated at 37° C. for one to three days before use for experiment. If $\frac{1}{4}$–$\frac{1}{6}$ c.c. of such culture be then injected subcutaneously into guinea-pigs, acute positive result will be produced in the great majority of instances.

Guinea-pig experiment No. 1.

*Experiment* XIII.—On October 6th, 1890, five guinea-pigs were inoculated with a salt-mixture of gelatine culture of the diphtheria bacillus, which was three months and a half old.

On October 8th three of the guinea-pigs had marked swelling at the site of inoculation.

On October 9th one guineapig was found dead, and a second very ill. Material from the induced swellings of the above guinea-pigs when inoculated on gelatine yielded numerous colonies of the diphtheria bacillus.

On October 14th a second guinea-pig was found dead.

On October 15th a third guinea-pig was found dead.

On October 22nd a fourth guinea-pig was found dead.

On October 24th the fifth and last guinea-pig was found dead.

Each of these five animals had, *post-mortem*, at the seat of inoculation a firm necrotic tumour, and cultivations made with a particle of its tissue yielded numerous colonies of the diphtheria bacillus.

This gelatine culture three months and a half old must then be regarded as having been an attenuated one, since of the five experimental animals one died on the 4th, one on the 9th, one on the 10th, one on the 19th, and one on the 21st day.

Guinea-pig experiment No. 2.

*Experiment* XIV.—On November 12th a broth culture incubated at 37° C. for 48 hours was used for subcutaneous inoculation of six guinea-pigs, each receiving $\frac{1}{8}$–$\frac{1}{4}$ c.c. in the groin. A companion broth tube having been exposed to 70° C. for five minutes (and hereby quite sterilised, since inoculations from it of broth and Agar tubes remained barren of growth) was two hours later used for further inoculation of four of the above six guinea-pigs. These four guinea-pigs will be referred to as the "vaccinated" guinea-pigs, and the remaining two as the "control" animals.

On November 13th one of the four "vaccinated" animals was found dead. A second "vaccinated" guinea-pig was very ill, and the other two much indisposed. Meanwhile the "control" animals had also become ill, but not to so striking an extent as the "vaccinated" ones.

On November 14th all six guinea-pigs, "vaccinated" and "control" alike, were found dead with the appearances typical of the diphtheria malady.

In this experiment, therefore, the second inoculation, that with sterilised culture, tended if anything to accelerate the action of the first inoculation.

Guinea-pig experiment No. 3.

*Experiment* XV.—On November 14th six guinea-pigs were inoculated with gelatine culture of the diphtheria bacillus, a fortnight old. Two of the six were made to serve as control animals. The other four were re-inoculated two hours later with broth culture of the organism (48 hours old) previously sterilised by boiling it for one minute. One and a half divisions of a Pravaz syringe of the sterilised broth culture were injected in each instance.

On November 15th all six guinea-pigs had each a slight swelling at the seat of inoculation; but none seemed ill, all being fairly lively.

The four experimental guinea-pigs were therefore again injected with the same material and in the same quantity as before.

On November 17th one "control" and one "vaccinated" guinea-pig were very ill and shaky when they tried to move. The other three "vaccinated" and both "control" guinea-pigs had now conspicuous swelling at the seat of inoculation.

One November 18th one of the "control" and one of the "vaccinated" animals—those noticed the previous day as very ill—were found dead, both with appearances typical of the diphtheria malady. A second "vaccinated" guinea-pig had great local swelling and was dying. The remaining two experimental guinea-pigs were on that day and on November 19th, 20th, and 21st further injected with same boiled broth culture as before.

The remaining "control" animal and both these "vaccinated" guinea-pigs had at the last-named date big firm swellings at the site of the first inoculation; and they died on November 28th, *i.e.*, a fortnight after the inoculation with living diphtheria culture. Cultivations made from the tumours at the sites of the inoculation in these animals yielded numerous colonies of the diphtheria bacillus.

These two series of experiments, XIV. and XV., tend to show that no inhibition of any kind is produced in the guinea-pig that has been previously inoculated with living diphtheria culture, by subsequent repeated injection of it with sterilised broth culture of the diphtheria bacillus; the disease started by the living diphtheria bacilli would seem unmodified by the subsequent injection of the diphtheria toxins, be the culture which set it going, recent and virulent as in Experiment XIV., or of some standing and less virulent as in Experiment XV. And this was confirmed by further experiments.

Guinea-pig experiment No. 4.

*Experiment* XVI. comprised several series of additional guinea-pigs dealt with in exactly the same manner as in Experiments XIV. and XV. In some of the sub-experiments virulent recent broth culture, in others Agar culture several days to several weeks old, was used for primary inoculation, while for "vaccination" and "revaccination" boiled and sterilised broth culture was employed. In each series two animals were kept for control, and four others were "vaccinated" and "revaccinated" on several subsequent days, 1½–3 minims of sterilised culture being injected in each case. The result, as has been said, coincided completely with those of Experiments XIV. and XV.

It must be concluded then that diphtheria disease once started in the guinea-pig by injection into that animal of a living culture of diphtheria bacilli, proceeds unimpeded whether or no the toxins of a sterilised broth culture be injected on several subsequent days. If anything this re-injection seemed in some animals rather to accelerate than retard the disease process.

No good prospect of arresting induced diphtheria disease in the guinea-pig was therefore to be expected from subsequent inoculation with diphtheria toxins.

As a last series I have to mention experiments of similar sort in which after a primary inoculation of the guinea-pig with diphtheria bacillus, cultivations of the bacillus pyocyaneus (both living and sterilised cultures) were used for "vaccination" and "revaccination" of the experimental animal. As a result a notable acceleration of the diphtheria disease in the guinea-pig was effected, as is recorded in detail in a separate report, pp. 243–46.

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In concluding this paper I have briefly to note observations made by me on what I propose provisionally to term "casual diphtheria" in the cow and in the cat.

## Casual Diphtheria in the Cow.

Cow-diphtheria.

On November 4th, 1890, with assent of the Medical Officer of the Board, I visited, with Dr. Philpot, Medical Officer of Health of Croydon, a certain farm near Croydon, milk from which had been found by Dr. Philpot to have conveyed diphtheria to a large number of persons in his district. Dr. Philpot had not been able to find in conditions of the dairy, of the persons employed there, or of persons acting as milk distributors, any satisfactory explanation of the observed infectivity of the milk. And he was disposed therefore to suspect the cows themselves as at fault in the matter.

At the farm in question we found a cow, which had come there about the 29th of September, upon which at the date of our visit (4th November) were observed, on the right hind teat, two healing ulcers with slightly indurated skin in their neighbourhood. A second cow had on left hind teat several round ulcers $\frac{1}{12}$–$\frac{1}{6}$ inch in diameter covered with brown crusts. On her right hind teat was another round ulcer the size of a sixpence covered with a brown scab. A third cow had on every teat round sores, some small, $\frac{1}{12}$ inch in diameter, others three times as large, all covered with scabs. The sores in this cow were, according to the milker, only about a couple of days old; those in the second cow were similarly said to be about three days old.

There were in the same shed other cows which showed on their teats round sores, some contracted and almost healed, others still covered with brown crusts.

From the nature and character of these sores, and from the history I obtained of them, it was quite clear that there existed amongst the cows at this farm a contagious ulcerative eruption on the teats; an eruption moreover very much like that occurring in the cows experimentally inoculated by me, last year and this year, with cultivation of the diphtheria bacillus.

Another instance of eruptive disease in the cow concurrent with diphtheria among persons consuming her milk, was brought to my notice by Dr. George Turner, Medical Officer of Health for Hertfordshire. This occurred early in April 1891, at a farm not many miles from Bishop's Stortford. Dr. Turner took me to the farm, where we found a cow showing on several teats small round ulcers; some contracting and healing, others recent and covered with thin crust. A second cow at this farm had on one teat a big round sore, about $\frac{1}{2}$-inch in diameter, covered partly with thin crust. A third cow had two sores on her teats, and three round contracting sores on base of the udder; the skin about

these sores was much indurated, and the sores themselves still covered with thin brown crust. Dr. Turner had satisfied himself that diphtheria in certain human beings was to be referred to the milk coming from this farm, and further, that the milk at this farm could not have received the contagium of diphtheria from any human source there.

In both these instances, be it observed, of cow disease associated with diphtheria among consumers of the milk of the affected cows, we have the same character of eruptive malady in the cow, namely, round ulcers, for the most part small, only $\frac{1}{12}$-inch in diameter, though others measured $\frac{1}{8}$–$\frac{1}{2}$-inch; ulcers of different ages, some older ones contracting and healing, others more recent and covered by thin brown crusts, and in certain of the ulcers a peculiar nodular induration of the base of the sore. These several characters were, it will be remembered, all of them noticed in the eruption induced by me on cows in this and in last year's experiments by subcutaneous injection of bacillus diphtheriæ.

## Casual Diphtheria in the Cat.

Cat diphtheria.

It will be remembered * that by a curious accident an epidemic of cat diphtheria was observed at the Brown Institution, during the spring of 1890, at a time when the two experimental cows, Nos. 1 and 2, had eruption on their udders, and the diphtheria bacilli in their milk. It will likewise be remembered that the outbreak commenced in two cats that had for some days been fed on the milk of the cows in question. I have now to speak of a similar epidemic of cat-diphtheria, which occurred amongst the store cats at the Brown Institution in 1891.

Since last summer cats have continued to be kept at the Brown Institution, but until the beginning of March 1891 no illness was observed amongst them. On January 27th I, again at the Brown Institution, inoculated subcutaneously two cows (Nos. 7 and 8, pp.223–26 of this report) with cultivation of the diphtheria bacillus, with the result of inducing in them, among other symptoms, udder eruption which in the case of one of the cows still persisted at the beginning of March. On March 5th I was informed by the chief attendant at the Institution that two of the store cats there had died on the previous day, and that other four cats were ill. Their symptoms were the same as those observed in last year's cat epidemic, namely, sneezing and running of eyes and coughing; the animals were very quiet, did not take their food, and were evidently very ill. On post-mortem of the two cats that had died 4th March, there was found pneumonia of both *lungs* (viz., grey patches of consolidation), and large white *kidney* with fatty degeneration of the cortex. These two cats it appeared had been ailing since about the third week in February. The other four cats referred to as ailing on March 5th had been ill a few (2–4) days only. One of them—ill since March 2nd—was bad, drowsy. At the inner angle of each eye was a mass of muco-purulent matter; the animal could not swallow, lay on its side, and was very emaciated. When killed, 6th March, it presented the following post-mortem appearances:—A few grey patches of consolidation in each *lung;* in the upper part of the *trachea* and the lower part of the *larynx* the mucous membrane covered with a grey adventitious membrane very much like that of croup. Both *kidneys* showed whitish fatty patches in the cortex.

Microscopic specimens of the membrane from the trachea, revealed a remarkable number of bacilli in small and large groups, which organisms closely resembled typical diphtheria bacilli. Many of them were club-

* Report of the Medical Officer of the Local Government Board for 1889, pp. 174–76.

shaped, some showing the swelling at both ends, others showing the segregation of protoplasm.

The other three cats, though distinctly ill on March 6th, 7th, 8th, gradually got better, and in the end quite recovered.

We have here, then, a remarkable repetition, at the Brown Institution, of exactly the same disease in cats that was observed there in these animals last year, and which corresponded clinically and pathologically with "natural" diphtheria in cats. As last year so also this year, the disease occurred at the Brown Institution only when there were cows there which as a result of inoculation with diphtheria material had become affected with udder eruption. During the whole interval, when no diphtheria cows were at the Institution, no similar cat disease occurred there.

No doubt, in 1891 as in 1890, the cow malady was transmitted to the cats, but the method by which it was conveyed on this last occasion is not clear. Though in 1890 the cat first taken ill had been fed with milk from the experimental cows, this cannot be affirmed for 1891. The attendants of the Institution, whose duty it was to feed and milk cows Nos. 7 and 8 and to feed the store cats, deny that milk of these cows was at any time given as food to the cats in question.

PLATE I.

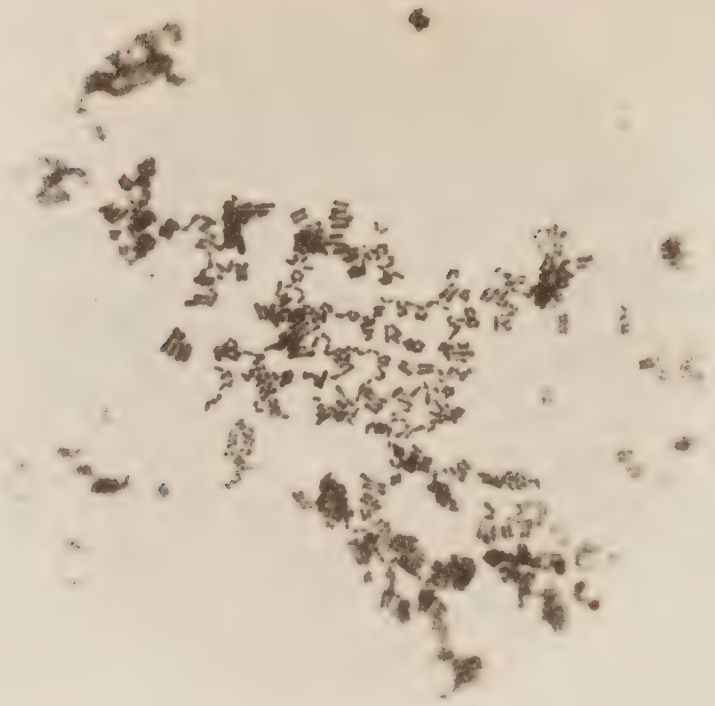

FIG. 1.

FIG. 2.

FIG. 3.

## ETIOLOGY OF DIPHTHERIA.

### PLATE I.

FIGS. 1 and 2.

Reproduced from photographs* of cover-glass specimens of material from cultures on *gelatine* of the *pseudo-diphtheria* bacillus obtained *February 20th* from the milk of Cow No. 8.

Magnifying power, Fig. 1, 650.
,, ,, Fig. 2, 1,000.

FIG. 3.

Reproduced from a photograph* of a cover-glass specimen of material from a culture on *gelatine* of *bacillus diphtheriæ* obtained *February 23rd* from the milk of Cow No. 8.

Magnifying power, 650.

---

[* *The photographs for this volume were taken by Mr. E. C. Bousefield. The "reproductions" of the photographs are by the Autotype Company.*]

## ETIOLOGY OF DIPHTHERIA.

### PLATE II.

FIGS. 4 and 5.

Reproduced from photographs of cover-glass specimens of material from cultures on *gelatine* of *bacillus diphtheriæ* obtained *February* 23*rd* from the milk of Cow No. 8.

Magnifying power, Fig. 4, 650.
,, ,, Fig. 5, 1,000.

FIG. 6.

Reproduced from a photograph of a cover-glass specimen of material from a culture on *gelatine* of *bacillus diphtheriæ*, obtained (after death) from the local tumour induced in a mouse by subcutaneous inoculation of this animal with the bacillus referred to.

Magnifying power, 1,000.

[Fatal result in the mouse (with production of a local tumour containing the bacillus diphtheriæ) from inoculation of this animal with the bacillus in question, is only obtained in a small percentage of instances. Mice are far less susceptible of diphtheria disease than guinea-pigs.]

PLATE II.

FIG. 4.

FIG. 5.

FIG. 6.

Fig. 7.

Fig. 8.

Fig. 9.

Fig. 10.

Fig. 11.

Fig. 12.

## ETIOLOGY OF DIPHTHERIA.

### PLATE III.

FIG. 7.

Reproduced from a photograph of colonies *on the surface* (slanting) of nutrient *gelatine*, *after two weeks'* incubation at 20° C., of *bacillus diphtheriæ*. The growth in question was a sub-culture derived from human diphtheria membrane.

Natural size.

FIG. 8.

Reproduced from a photograph of a *stab-culture in gelatine*, after *several weeks'* incubation at 20° C., of *bacillus diphtheriæ* from a similar source.

Natural size.

FIG. 9.

Reproduced from a photograph of a *stab-culture in gelatine*, after *several weeks'* incubation at 20° C., of *bacillus diphtheriæ* from the local tumour induced in a cow by subcutaneous inoculation of this organism.

Natural size.

FIG. 10.

Reproduced from a photograph of a culture on the *slanting surface* of gelatine of a sample of the milk taken on *February 23rd* from Cow No. 8.

Natural size.

[The course of the milk drop, as it gravitated from the upper to the lower part of the slanting culture medium, is here well seen; and on the surface of the gelatine will be observed, in early stage of growth, nine colonies which on sub-culture proved bacillus diphtheriæ.]

FIG. 11.

Reproduced ftom a photograph of a *streak-culture on Agar*, after *a few days'* incubation at 37° C., of the *pseudo-diphtheria bacillus* obtained *February 20th* from the milk of Cow No. 8.

Natural size.

FIG. 12.

Reproduced from a photograph of colonies *on the surface of Agar*, of the same *pseudo-diphtheria bacillus*, after a *few days* incubation at 37° C.

Natural size.

## ETIOLOGY OF DIPHTHERIA.

### PLATE IV.

Appearance presented by the eruption on the teat and udder of Cow No. 9 on the eighth day after subcutaneous inoculation into this animal of *bacillus diphtheriæ* derived from a human source.

pidge, del.

Judd & Co. Ltd. Lith. Doctors' Commons, London.

Fig. 1.

Fig. 2.

M.H.Lapidge, del.

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## ETIOLOGY OF DIPHTHERIA.

### PLATE V.

FIG. 1.

Appearance presented by the eruption on the upper lip of the calf of Cow No. 9, on the 9th day after subcutaneous inoculation of its mother with *bacillus diphtheriæ*.

FIG. 2.

Appearance presented by the upper lip of the calf of Cow No. 9, seven days later than that illustrated by fig. 1.

## No. 2.



### Further Observations on Concurrent Inoculation of Different Infections in the same Animal Body; by Dr. Klein, F.R.S.

On concurrent Inoculation of different Infections in the same Animal Body; by Dr. Klein.

In continuation of last year's (1889) observations, I give further details respecting the influence, one on another, of different infections introduced concurrently or in sequence into the same experimental animal. The dual infective processes that have since been under investigation are dealt with under the headings:—I. Bacillus diphtheriæ and bacillus anthracis; and II. Bacillus diphtheriæ and bacillus pyocyaneus. The experimental animals have been in every instance guinea-pigs.

#### I. *Bacillus Diphtheriæ and Bacillus Anthracis.*

B. Anthracis and B. Diphtheriæ;

Since guinea-pigs are very susceptible to both these infections, test of the influence of the one on the other within the bodies of these animals promised to be of interest.

*Experiment* I.—An Agar tube having been inoculated on May 19th with blood of a guinea-pig dead of virulent anthrax, there was established therein by May 31st copious growth of anthrax, with spore formation. Similarly, an Agar tube having been inoculated with diphtheria bacillus on May 23rd, had by May 31st developed copious growth of this organism. A particle of each growth was now mixed up separately in a sterile solution, so as to form in each instance a turbid fluid. These solutions were used on the same day (31st May) in the following experiments:—

(*a*.) A guinea-pig (hereafter to be styled the anthrax control animal) was inoculated with anthrax-salt-mixture alone.

(*b*.) A second guinea-pig (hereafter to be styled the diphtheria control animal) was inoculated with diphtheria-salt-mixture alone.

Simultaneously inoculated;

(*c*.) Other two guinea-pigs were inoculated each in the right groin with the anthrax fluid, and each in the left groin with the diphtheria fluid.

On June 2nd the control anthrax guinea-pig was found dead of typical anthrax. So, too, the two (*c*) guinea-pigs were on this date found dead, both of typical anthrax.

On June 3rd the diphtheria control guinea-pig was found dead, and presented post-mortem the phenomena customary in these animals after death by inoculation with diphtheria material.

the anthrax induced, not modified.

Hence it appears that given concurrent inoculation of virulent diphtheria material and of virulent anthrax material, the guinea-pigs experimented on succumb to typical anthrax after the interval customary when anthrax material *alone* has been introduced into their bodies.

*Experiment* II.—In this experiment it was sought to ascertain the behaviour towards anthrax of guinea-pigs which had been previously made subjects of inoculation of the diphtheria bacillus.

B. anthracis inoculated subsequent to diphtheriæ;

(*a.*) On June 3rd three guinea-pigs were inoculated with salt mixture of Agar diphtheria cultivation. On June 5th each of them had a tumour at the seat of inoculation, and all were rather quiet. Each was now inoculated with blood of a guinea-pig dead of anthrax, and on June 7th (in 48 hours) all three animals were found dead of typical anthrax.

(*b.*) On June 12th six guinea-pigs were inoculated each with a small amount of salt mixture and Agar diphtheria culture of 11 days' incubation. The object in view in using this culture of some standing was to produce a rather slower diphtheria process than in the previous cases. One of these six guinea-pigs died after two days, other three after four days, while the remaining two seemed well and lively on June 19th, seven days after inoculation, when only a trace of swelling could be felt at the seat of inoculation. Accordingly, at this date, *i.e.*, June 19th, these two guinea-pigs were inoculated with blood of a guinea-pig that had recently died of virulent anthrax. Before 48 hours were over both of them were found dead with typical anthrax.

result as before.

This appears to indicate that antecedent inoculation with the diphtheria bacillus, even when the disease produced thereby is prolonged over several days, fails to exert any influence in modifying the effect of subsequent anthrax infection.

## II. *Bacillus Diphtheriæ and Bacillus Pyocyaneus.*

B. Diphtheriæ and B. Pyocyaneous.

As Bouchard, Charrin, and others have shown, this microbe occurs in so-called blue pus. Also they have shown that there exists a remarkable antagonism between it and bacillus anthracis, inasmuch as the chemical products of the bacillus pyocyaneus injected into rabbits or guinea-pigs, antecedent to or concurrently with inoculation of these animals with bacilli of anthrax, prevents development in them of anthrax disease. Woodhead and Wood have confirmed these observations.

B. pyocyaneus alone inoculated.

It occurred to me therefore to test in the animal body the bacillus pyocyaneus in relation with the bacillus diphtheriæ. And first it appeared necessary to ascertain the action on guinea-pigs of the bacillus pyocyaneus itself; as to which for illustration of its cultural characters on Agar and in gelatine, see figs 1, 2, and 3, Plate VI. With reference to its appearance in dried and stained cover-glass specimens, see fig. *x*, Plate VII. Two guinea-pigs were therefore inoculated in the subcutaneous tissue of the groin with several drops of a broth culture of the bacillus pyocyaneus.* These guinea-pigs each showed next day a large painful swelling in the groin, and appeared very quiet. One animal died after 30 hours, the other after 40 hours. In both there was found post-mortem much œdematous hæmorrhagic swelling in the groin about the seat of inoculation; and internally, severe peritonitis with copious formation of purulent false membranes over liver, spleen, and parietal wall of abdomen. This peritonitis it was that

* Broth inoculated with this bacillus and kept at 37° C., is uniformly turbid, and slightly tinted greenish-blue, in so short a time as 24 hours. The tint deepens on further incubation, and after several days there is loose, grey, thin, floccular deposit; while on the surface of the broth appears a viscid grey pellicle. The whole broth seems turned into a thin jelly, the pellicle and floccular deposit mixing badly with the jelly. When pouring the contents of the culture-tube into a vessel, the jelly-like character of the broth becomes very conspicuous. On the surface of Agar the growth has the character of a tenaceous viscid pellicle, the Agar itself assuming a greenish blue colour, which gradually deepens as growth proceeds. In gelatine, slow liquefaction takes place, the superficial layers becoming beautifully tinted greenish-blue.

On concurrent Inoculation of different Infections in the same Animal Body; by Dr. Klein.

had caused death of the animals. In the local œdema and in the peritoneal exudation, numerous pyocyaneus bacilli could be demonstrated in cover-glass specimens, and cultivations made from both localities produced abundant colonies of this bacillus. In neither of these particular animals were pyocyaneus bacilli demonstrable in the heart's blood; but in other guinea-pigs subjected to similar experiment colonies were obtained therefrom. These other experimental guinea-pigs had been inoculated with $\frac{1}{4}$-$\frac{1}{8}$ c.c. of broth culture of the bacillus pyocyaneus, and in all of them local œdema and death in 1–3 days with severe peritonitis and purulent pseudomembranes, was the result. In each case the local œdema and the peritoneal exudation also contained the bacillus pyocyaneus very abundantly. It is therefore sufficiently clear that in broth culture this bacillus has a pathogenic action on guinea-pigs of a considerable degree of virulence.

Products of b. pyocyaneus injected subsequently to b. diphtheriæ;

*Experiment* III.—Six guinea-pigs were now inoculated subcutaneously, on January 22nd, with salt mixture of a gelatine culture of the diphtheria bacillus incubated since December 11th. Two of them were kept as control animals, while the remaining four were half an hour later injected subcutaneously with three minims of a *sterilised* broth culture of the bacillus pyocyaneus. This broth culture had been incubated at 37° C. for several days before it was sterilised by exposing it for five minutes to a temperature of 60° C. Complete sterilisation of a test-tube culture once effected, subcultures therefrom prove always also sterile.

On January 23rd all six guinea-pigs had a slight swelling at the site of the diphtheria injection, but took their food well. The four guinea-pigs of experiment were at this date re-inoculated, each with three minims of the sterile pyocyaneus broth culture.

On January 24th one of these four experimental animals was found dead; the other three were at this date very quiet and ill.

induced diphtheria, enhanced.

On January 28th the remaining three were found dead. But the two control animals did not die till February 3rd. So that superaddition to diphtheria inoculation, of inoculation with sterile culture of the pyocyaneus appears to have in the four experimental animals accelerated the diphtheria disease considerably.

This experience therefore is in strong contrast with, for instance, that of Charrin in regard to anthrax. He found anthrax of the guinea-pig inhibited, not accelerated, by inoculation of these animals with the chemical products of bacillus pyocyaneus.

Further illustration of the fact that inoculation of diphtheria-guinea-pigs with the chemical products in a pyocyaneus culture tends if anything to enhance the action of the diphtheria bacillus, is afforded by the following experiment.

Experiment repeated;

*Experiment* IV.—On January 26th six guinea-pigs were inoculated subcutaneously with five minims of a broth culture (four days old) of the diphtheria bacillus. Four of them were two hours later further inoculated subcutaneously with one minim each of *sterilised* broth culture of the bacillus pyocyaneus.

On January 27th these four animals were re-inoculated with one minim each of the same sterilised pyocyaneus culture.

result as before.

In the morning of January 28th one of the control guinea-pigs died, presenting at this date a big tumour at the site of inoculation. In the evening of the same day the other control guinea-pig died. Meanwhile all four of the guinea-pigs of experiment had died on the night of January 27th—28th.

Summary.

And as with the sterilised so with non-sterilised cultures of bacillus pyocyaneus. Broth cultures containing the living organism itself had,

when inoculated into guinea-pigs, no effect in checking diphtheria disease previously set going in these animals; as was proved by several experiments. These further experiments subjected guinea-pigs to injection of one minim each of living broth culture of bacillus pyocyaneus on two separate occasions, 2 hours and 24 hours respectively, after previous inoculation with bacillus diphtheriæ. As a result, in every instance the animals of experiment died of diphtheria disease earlier than the control animals.

There can be no question then as to the relations of the diphtheria bacillus and the bacillus pyocyaneus being fundamentally different from those previously proved to exist between the bacillus anthracis and bacillus pyocyaneus.

A large number of important experiments of similar sort were next instituted as to relations of bacillus pyocyaneus and the bacillus of tubercle. These, which will be dealt with in a separate report, are still in progress. It may, however, be here stated that evidence has already been obtained justifying expectation that the chemical products of bacillus pyocyaneus will be found to have distinct inhibitory action on the tubercular process. [See in this connexion figs. *y* and *z*, Plate VII.]

Fig. 1.

Fig. 2.

Fig. 3.

M.H Lapidge, del.

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## CONCURRENT INFECTIONS.

### PLATE VI.

FIG. 1.

*Streak-culture* on the *surface of Agar* of *bacillus pyocyaneus;* after *five days'* incubation at 37° C.

Natural size.

FIG. 2.

*Stab-culture* in *gelatine* of *bacillus pyocyaneus;* after *five days'* incubation at 20° C.

Natural size.

FIG. 3.

The stab-culture represented in fig. 2, after *ten days'* incubation.

Natural size.

[In both the above stab-cultures the surface of the gelatine was in process of becoming liquefied: liquefaction having advanced further in the case of fig. 3 than in fig. 2.]

## CONCURRENT INFECTIONS.

### [PLATE VII.

FIG. *x*.

Reproduced from a photograph of a cover-glass specimen of material from a culture on *Agar* of *bacillus pyocyaneus*.

Magnifying power 1,000.

FIG. *y*.

Reproduced from a photograph of a cover-glass specimen of material from the interior of a *tubercle* in the capsule of the spleen of a guinea-pig that *eleven weeks* subsequent to inoculation with *tubercular material* had been repeatedly injected subcutaneously with *sterilised* culture of *bacillus pyocyaneus*.

Magnifying power 650.

[The bacilli here shown, which were typical *tubercle bacilli*, were most of them contained within cells.]

FIG. *z*.

Reproduced from a photograph of a similar cover-glass.

Magnifying power 1,000.

The six large cells deposited in the photograph, each contained numbers of *tubercle bacilli*. Elsewhere in the specimen,—as shown in the lower part of the photograph,—the tubercle bacilli were free.

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[*The photographs for this volume were taken by Mr. E. C. Bousefield. The "reproductions" of the photographs are by the Autotype Company.*]

PLATE VII.

FIG. *x*.

FIG. *y*.

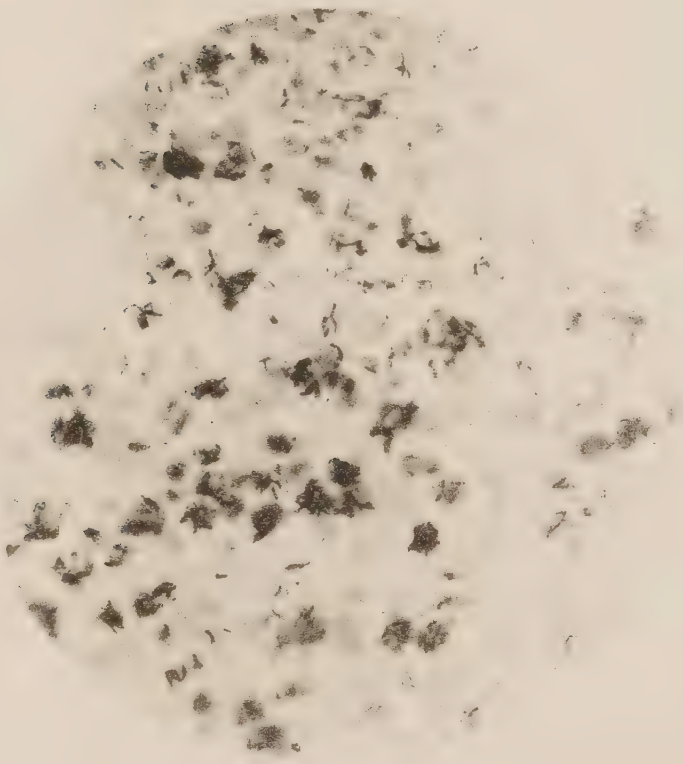
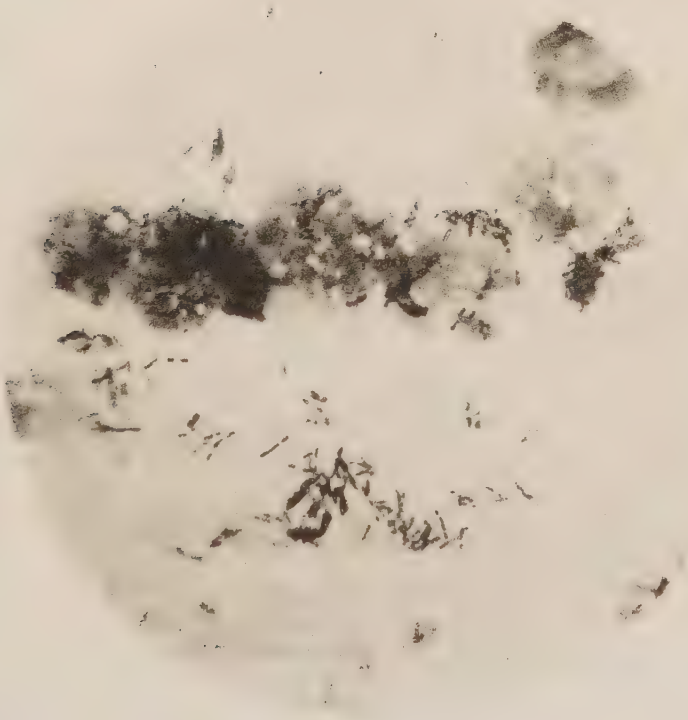


FIG. *z*.



No. 3.



## Report on Meat-Pie Poisoning at Portsmouth; by Dr. Klein, F.R.S.

Dr. Mumby, Medical Officer of Health of Portsmouth, reporting to his Sanitary Committee on an outbreak of diarrhœa at a school in that borough, tells a story of food-poisoning as follows:—

"On February 26th, the day on which the Queen launched "H.M.S. 'Royal Arthur,' nine boys and a master returned from "viewing the launch, getting to the school house about 2 o'clock. "They then had dinner, at which meal they partook of two cold "meat pies. The meat pies had been made and cooked the "previous day, together with a third meat pie, some treacle pies, "and some tartlets. The meat was bought fresh from the butcher's "for the purpose; nothing else was used except the fresh meat and "the paste. The same paste was used for the meat pies and "treacle pies and tartlets. Later in the afternoon the same meat "pies were partaken of by two maid-servants and a man-servant. "Whilst eating the pies it was remarked that the meat was tough, "but nothing else was noticed about the pies. One boy finding "the meat tough contented himself by eating the paste and gravy "only.

"No ill effects were discovered until about four o'clock on the "following morning, when one of the boys was awakened with "cramp in the abdomen and diarrhœa. Within three hours of that "time, and with only a single exception, every one who had "partaken of these meat pies was taken ill in the same way. The "boy who only eat one mouthful of meat but eat freely of the "gravy and paste was as ill as those who had eaten more meat. "The chief symptoms were pains in the abdomen, diarrhœa, "headache, and malaise; all of them gradually passed off, none of "the patients remaining ill more than 30 hours. The exception "above referred to was the man-servant who eat very little of the "pie, 'he hardly touched what was given him.'

"There were other boys and adults living in the house who eat "of the treacle pies and tartlets made of the same paste, but none "of them were taken ill.

"It would, therefore, appear that the cause of the diarrhœa was "contained in the meat or the gravy of the pies. I secured all "that remained of the second pie, and the whole of the third pie "which was untouched; the first pie had been entirely eaten. "Portions of the second and third pies I sent to Dr. Klein, F.R.S., "at the request of the Medical Officer of the Local Government "Board. Parts of the remaining portions I subjected to chemical "analysis in seeking for known irritant poisons, but by this "examination I did not make any discovery. I also made some "cover-glass preparations both from the meat and from the gravy "in order to look for micro-organisms. In the gravy of both pies "I found an immense number of rod-like bacteria, but I was not "able to pursue this examination further. The cover-glass pre-"parations made from the meat did not yield any bacteria."

On March 2nd I received from Dr. Mumby two jars containing "meat pie," cut up in pieces. One jar, labelled "Cut pie," contained the remains of a pie that had been partly consumed by persons who later

on were taken ill with diarrhœa. The other jar labelled "Uncut pie," contained part of a pie made at the same time, and from the same ingredients as the "Cut pie," but none of which had been consumed as food. The contents of both jars consisted of crust, pieces of beef, and fat, to which was adhering a good deal of jelly. These contents were without odour.

On microscopical examination of the jelly adhering to and surrounding the pieces of meat, there were observed in it very numerous bacteria, chiefly bacilli of various lengths. Some of these were mobile, some non-mobile; amongst them a few forms looked like diplococci. With a view to separate these forms, gelatine plates and Agar plates were inoculated with material from the jelly, the former plates being incubated at 20° C., the latter at 37° C. In this way it was ascertained that in the jelly of both pies each of two species of microbe (*a* and *b*) were very abundant, altogether outnumbering other sorts of organisms.

Species (*a*) is a short bacillus growing either singly or in dumb-bells, non-mobile and growing better in the Agar plates than in the gelatine plates; the former showed after 24 hours innumerable colonies of this organism, in fact in some plates it appeared almost in pure cultivation. Transferred from the Agar plates to gelatine tubes at 20° C. this species grew well. In *streak* culture hereon the streak of inoculation is, after 24 to 48 hours, marked as a translucent flat band with crenate edges (fig. *a*, Plate VIII.). After several days its breadth is several millimetres to one centimetre; flat and thin, its edges very ragged and crenate (Plate VIII., figs. *b* and *c*). In *stab*-culture (fig. *d*, Plate IX.) in gelatine it forms in the depth a greyish white line of dots; on the surface a thin crenate plate. The characters of the growth on and in gelatine are well shown in figs. *a* and *b*. Its appearance in cover-glass specimens, dried and stained in the usual way, are shown in figs. *e* and *f*, Plate IX. As will be seen from figs *a* and *b*, it grows better and quicker on the surface than in the depth (fig. *d*) of the gelatine. In broth it grows well, and forms uniform turbidity. Broth cultivations of this bacillus have no unpleasant odour; on the contrary they have a rather pleasant aromatic smell.

Species (*b*) is a mobile bacillus, soon forming by multiplication chains and threads, rapidly liquefying the gelatine and giving it a greenish colour. Liquefaction was pronounced as early as after 24 hours, and for this reason this species was easier obtained from the gelatine plates than from the Agar plates; moreover it does not grow on Agar at 37° C. so well as on gelatine at 20° C. This species too, while liquefying the gelatine, produced an offensive odour; in fact it appeared to be bacillus fluorescens liquescens, or a species very closely related thereto.

The third species, viz., the coccus mentioned above, was also isolated and proved to be a white slowly liquefying species of staphylococcus. Its numbers present in the jelly were however small.

Sub-cultures of these three species were next used for testing their pathogenic action, if any, on animals. But previous to this the pie itself received from Portsmouth had been tested on mice.

### *Feeding Experiments with Pie-Material.*

*Experiment* I.—(1.) On March 2nd, *i.e.* on the day of receipt of the jars, four mice were fed with pieces (jelly, meat, and crust) of the "Uncut" pie.

(2.) At the same time, additional four mice were fed with "Cut" pie.

On March 3rd these animals seemed all right. Those fed with the "Uncut" pie had eaten up the greater part of what was given them;

the others fed with "Cut" pie had not eaten more than a third of their allowance.

In the morning of March 4th three of the four mice fed with "uncut" pie were found dead; also two of the four fed with "Cut" pie. The post-mortem appearances in all six mice were identical, and they are thus recorded in my note-book:—

"The blood of the heart is fluid; both lungs much congested, the liver, kidneys, and spleen dark; spleen not enlarged; the small intestines relaxed and filled with mucus, in which was found a good deal of detached epithelium."

The last of the four mice fed with "Uncut" pie, which was distinctly ill on the morning of 4th of March, died that evening. It presented the same post-mortem appearances as in the others.

The other two mice fed with "Cut" pie remained alive.

*Experiment* II.—On March 4th, *i.e.*, the third day after receiving the pie-material, four mice were fed with "Uncut" pie, other four with "Cut" pie. At this date the materials had the odour of putrefaction.

Of the four mice fed with "Uncut" pie, one was found dead on March 9th; the other three, as also the four fed with "Cut" pie, remained unaffected. The post-mortem appearances of the mouse that died were identical with those already described.

*Experiment* III.—On March 7th both sorts of pie material were again used for feeding mice, four in each instance. By this date the putrefactive odour of the pie stuff had become so intense that the materials had to be destroyed. None of the eight mice fed on March 7th showed anything abnormal; they remained well.

From these experiments it appears that a decidedly poisonous action on mice was possessed by these pie-materials, but that such poisonous action gradually disappeared as putrefaction of these materials became pronounced.

By March 7th the rapidly liquefying species (*b*) alone of the above-mentioned organisms was obtainable by cultivation from the pie material, and hence it appeared clear that this (*b*) species had had no share in the poisonous quality of the pie; rather it was to be thought of as having been concerned in the putrefactive process which had become established in the pie-materials.

Direct experiment on mice, however, with (*b*) bacillus settled the question as to its lack of infective quality, since mice fed or inoculated with gelatine and broth cultures of this bacillus remained perfectly unaffected. And a like result was obtained from feeding mice with the species of coccus above mentioned as also isolated from the pie-jelly. But a different result appeared when the (*a*) species of bacillus was used for experiment,—as has now to be recorded.

### *Inoculation and Feeding Experiments with Bacillus (a) from the Pie-Material.*

*Experiment* IV.—With broth culture of species (*a*) two mice were *inoculated.* The broth culture had been incubated at 37° C. for three days, and about $\frac{1}{8}$ c.c. of it were injected under the skin of the back of each mouse. Both animals remained perfectly well. This experiment was repeated on two additional mice with the same negative result.

*Experiment* V.—With broth culture of species (*a*) two mice were *fed* on March 31st at about 11 a.m. In the afternoon both mice were found very ill; their coats were rough and their eyes small; they were very quiet, and their breathing was very rapid. On April 1st one of

these mice was still ill. The other seemed a little better; it moved about, its eyes were open, but its coat was still rough.

On April 2nd the first-mentioned mouse was found dead; the other was distinctly better and livelier, and in another 20 hours this animal had quite recovered.

The dead mouse presented the following post-mortem appearances:—Both lungs dark red, almost hepatised; liver, spleen, and kidneys dark; spleen not enlarged; the small intestine relaxed and full of mucus.

*Experiment* VI.—With broth culture of the organism, made on April 1st, four fresh mice were *fed* on April 4th. On April 5th, all four animals were distinctly ill. One died on the night of April 5th, but the other three gradually recovered; on April 6th they were again livelier, on April 7th they seemed quite recovered.

The post-mortem appearances of the mouse that died were identical with those of the former cases.

Attempt was made to recover from the bodies of the mice that died under experiment—whether after feeding with pie-material or with culture of the bacillus derived therefrom—the micro-organism that had been introduced into their bodies. To this end the heart's blood, the congested lung tissue, and the spleen pulp were duly examined and tested. But only from the mouse of Experiment V., that died on April 2nd, could the bacillus in question be recovered. In this case two gelatine tubes having been inoculated by rubbing over the slanting surface of the medium within them a particle of lung tissue, one tube remained sterile, whereas the other showed three colonies of the bacillus.

As a result of this investigation it would appear that the bacillus (*a*) forms in culture a chemical poison, which, when received by mice into their alimentary canal, produces illness and death of these animals; and that the post-mortem appearances in their bodies are identical with those that were produced by feeding mice with the pie itself.

Also it appears that bacillus (*a*) itself is not, *on inoculation*, pathogenic; inoculated into mice it produced no result whatever. This Portsmouth pie-poisoning, therefore, has much in common with former cases of food-poisoning investigated by me, notably with the Shrewsbury, Carlisle, and Retford cases reported on in previous years. It has to be added, however, that the organism now isolated is morphologically and culturally different from the three species found in the Retford, Shrewsbury, and Carlisle materials respectively.

FIG. *a*.

FIG. *b*.

FIG. *c*.

## MEAT-PIE POISONING.

### PLATE VIII.

FIGS. *a*, *b*, and *c*.

Reproduced from photographs of *streak-cultures* on *gelatine* of the *non-motile bacillus* from the Portsmouth pie :—

Fig. *a*,—appearance after *two days'* incubation at 20° C.
,, *b*,— ,, ,, *two weeks'* ,, ,, ,, ,,
,, *c*,— ,, ,, *four weeks'* ,, ,, ,, ,,

Natural size.

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[*The photographs for this volume were taken by Mr. E. C. Bousefield. The "reproductions" of the photographs are by the Autotype Company.*]

## MEAT-PIE POISONING.

### PLATE IX.

FIG. *d*.

Reproduced from a photograph of a *stab-culture in gelatine* of the *non-motile bacillus* from the Portsmouth pie; after *two days'* incubation at 20° C.

Nature size.

Fig. *e*.

Reproduced from a photograph of a cover-glass specimen of material from a culture on *gelatine* of the same bacillus.

Magnifying power 1,000.

FIG. *f*.

Reproduced from a photograph of a cover-glass specimen of material from a culture on *Agar* of the same bacillus.

Magnifying power 1,000.

PLATE IX.

FIG. *d*.

FIG. *e*.

FIG. *f*.

## No. 4.

## On the Chemical Pathology of Anthrax; by Sidney Martin, M.D.

On the Chemical Pathology of Anthrax; by Dr. Sidney Martin.

In my report* last year (1889–1890) I described experiments which demonstrated the following points:—

Result of previous work.

1. Anthrax bacilli grown in a solution of alkali-albumin (made from serum) transform the proteid into two albumoses resembling the proto- and deutero-albumose of peptic digestion. These were called anthrax-albumoses. The bacilli also formed a strongly basic body which was provisionally called an alkaloid.

2. Tested on mice, the physiological action of these products was as follows:—The pure albumoses, injected subcutaneously in large doses, induced a widespread local œdema, with the death of the animal by gradually increasing coma, the spleen being in some cases enlarged. The basic body, in much smaller doses, produced similar results, only much more rapidly, the spleen being constantly found enlarged. The basic (alkaloidal) body, in fact, appeared, as the phrase is, to "select" the spleen.

3. This basic body was regarded as formed from the albumoses, since the alkaline reaction given by them seemed to indicate that the base was in a nascent condition in the albumose molecule. Had the base been simply attached to the albumose, prolonged treatment with solvents and acids would, it was thought, probably have removed it. This was found not to be the case.

Directions of further research,

In my present report I propose to consider the following points:—

1. The chemical products of attenuated and of virulent anthrax bacilli.

2. The physiological action of the mixed anthrax products (albumoses and alkaloid), after subjection to heat.

3. The production in experimental animals of fever by means of these anthrax products.

4. The separation of these products from the tissues of animals suffering from induced anthrax, and experiment therewith on mice.

### 1. The Products of Attenuated and of Virulent Bacilli of Anthrax.

Anthrax products attenuated,

In my early artificial cultures I used an attenuated virus such as is usually bred in laboratories. A pure cultivation of these attenuated acilli was on inoculation fatal to mice, as also to guinea-pigs; but not to sheep, even when the splenic pulp of a guinea-pig killed by the anthrax culture was used for tneir inoculation. In the sheep it produced a local lesion, but no well-marked fever or other symptoms.

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* Report of the Medical Officer of the Local Government Board, 1889–1890, p. 235.

and of virulent cultures,

In my later experiments I used a virulent anthrax organism obtained in pure culture from the natural disease in the cow.

The differences of the growth of attenuated and of virulent anthrax bacilli in solutions of artificial serum, is one of degree not of kind. *The chemical products formed by both are the same.* But while the bacilli of the attenuated virus soon (in a fortnight or so) become degenerate and the products formed by them are always small in quantity, virulent bacilli will grow rapidly, will not so soon become degenerate, and will manufacture a large quantity of chemical products. It is therefore advisable always to use virulent bacilli for artificial cultivation. Attenuated bacilli and virulent bacilli, alike form spores.

chemically identical.

If several flasks containing the same strength of artificial serum be simultaneously inoculated with anthrax bacilli of the same culture, and one flask examined at the end of a week, another at the end of two weeks, and so on, it will be found that albumoses are the first products formed from the alkali-albumin, but little alkaloid being then present; that as the base increases in quantity the albumin and albumoses diminish, until a culture is at length obtained in which the proteid has been transformed almost completely into the base. This appears to be a direct proof that the base is formed by the bacillus from the proteid present in the culture medium. If incubation of the culture be further continued the proteid disappears altogether; but the base also diminishes in quantity, being apparently decomposed.

## 2. The Physiological Action, after Boiling, of the Mixed Anthrax Products.

Boiling anthrax products

By mixed products is meant the mixture of albumoses and base obtained from an artificial serum culture three or four weeks old.

These products concentrated at 100° C., and inoculated subcutaneously into mice, gave results as follows:—

| Wt. in Grams. of Mouse. | Dose injected. | | Dose per Kilo. Body-Weight of Animal. | | Effect of Inoculation on Experimental Animal. |
|---|---|---|---|---|---|
| | Albumose. | Base. | Albumose. | Base. | |
| 31 | 0·012 | 0·018 | 0·38 | 0·58 | Sluggish for 3 days; recovered. |
| 32 | 0·012 | 0·018 | 0·37 | 0·56 | |
| 25 | 0·018 | 0·028 | 0·75 | 1·15 | Comatose in 2½ hours; death in 19 hours. Large local œdema; spleen enlarged and congested. |
| 23 | | | 0·8 | 1·24 | |
| 23 | | | 0·8 | 1·24 | In a state of stupor in 19 hours; recovery in 4 days. |

fails to destroy their activity:

This experiment (confirmed by others) shows that prolonged boiling does not destroy the physiological activity of the anthrax products. But the above recorded toxic and fatal effects are to be ascribed chiefly to the base and not to the albumose, since, as was shown in my last report (*op. cit.* p. 246), prolonged boiling destroys the activity of the albumoses.

If the culture filtrate instead of being boiled be concentrated in vacuo at 35°–40° C., the mixed products have an action similar to that just stated. Thus, in the case of a guinea-pig weighing 641 grammes, 0·03 grm. of albumose and 0·17 grm. of the base in 10 minims of water were injected into the thigh. In a little under 24 hours there was well-marked local œdema, but no apparent illness of the animal except *fever*. In 48 hours double this dose was injected into the other thigh. In two hours the animal was in a state of stupor, with local œdema. The stupor passed into coma which lasted with varying intensity for 50 hours, when recovery ensued. During this time the œdema spread all over the side of the abdomen and thorax up to the fore legs. Although death did not result, the action of these mixed products was to produce a *spreading* local œdema with fever (*see* Chart II.), and coma. The symptom coma, must however be in great part ascribed to the base, as the dose of albumose given (0·09 grm. in all) does not by itself produce this symptom (*see* Chart III.).

so, too, concentration of the products in vacuo.

### 3. The Production of Fever by means of the Anthrax Products.

Fever is induced by anthrax products,

These experiments with reference to fever, and to the amount and duration of it, were performed on guinea-pigs. The temperature was taken in the rectum at frequent intervals before and after the injection of the poison.

The rectal temperature of the guinea-pig varies about 2° F. The average of 61 observations on 12 healthy animals in mid-winter (November to January) was 100·06° F. (37·8° C.). The temperature is sometimes as low as 99·8° F. (rarely 99° F.), and sometimes as high as 101·4° F.

It was found best, therefore, to take the temperature not less frequently than every two hours during a part of the day preceding the inoculation, and to contrast the average normal temperature thus ascertained with the average temperature observed after the inoculation.

The following table shows the average temperature of nine individual normal guinea-pigs (5–8 observations on each) :—

| | | | | |
|---|---|---|---|---|
| 99·3° F. | - | - | - | 37·3° C. |
| 99·6° | - | - | - | 37·5° |
| 99·7° | - | - | - | 37·6° |
| 100·3° | - | - | - | 37·9° |
| 100·5° | - | - | - | 38·° |
| 100·6° | - | - | - | 38·1° |
| 100·7° | - | - | - | 38·2° |
| 100·7° | - | - | - | 38·2° |
| 100·8° | - | - | - | 38·3° |

#### (a.) *Effect of the mixed anthrax products concentrated in vacuo at 35°–40° C.*

whether concentrated in vacuo

*Experiment I.*—Two doses given of albumose 0·03 grm., and of base 0·027 grm. Total dose of each, 0·06 and 0·054 gramme respectively.

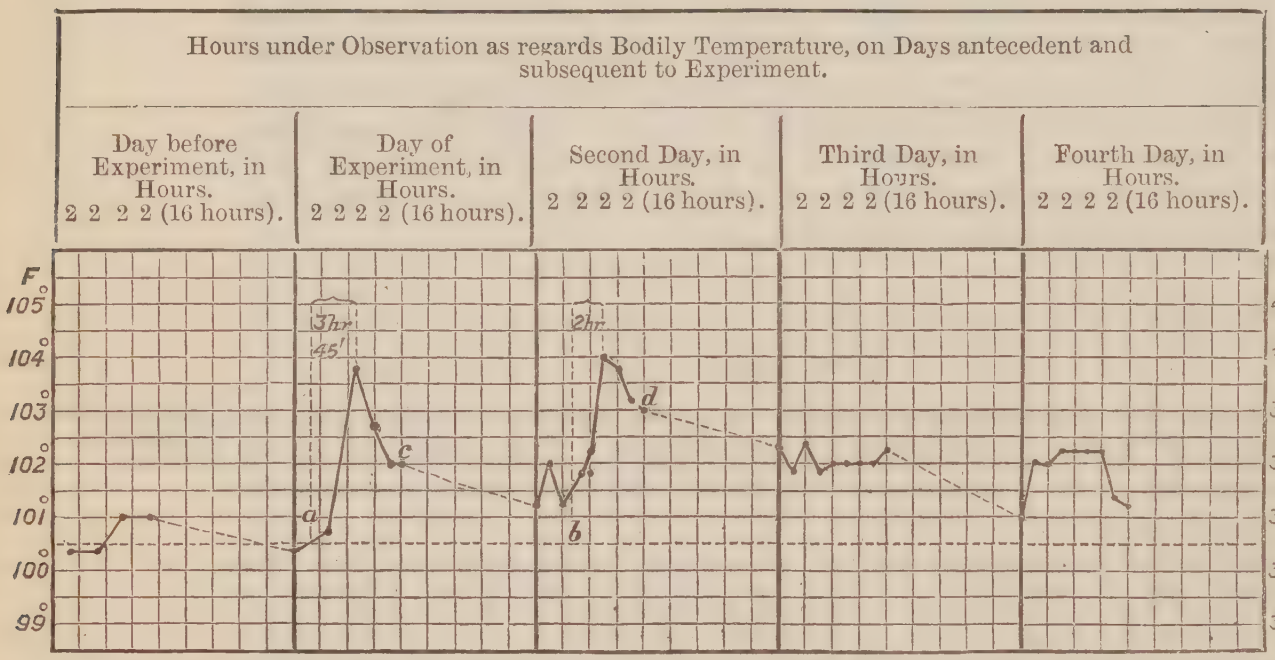
After the first dose there was a febrile period of $3\frac{3}{4}$ hours, at the end of which the temperature was found to have suddenly risen 3° F. above the average normal. The next morning, the temperature having not yet fallen to the normal average, the second dose was given. It was followed, after two hours, by a higher rise of temperature than was produced by the first dose, and the animal remained slightly febrile for over

48 hours (*see* Chart I.). There was no stupor or coma or any constitutional symptom except fever. There was however well-marked local œdema.

## Chart I.

Guinea-pig weighing 522 grammes.—Amount injected on each occasion:—albumoses, 0·03 gram., base 0·027 gram. Total dose in each instance per kilo. body-weight of animal, 0·113 and 0·103 gram. respectively.

Result.—Besides the sudden rise of temperature, great local œdema; no general symptoms.




*a*. First injection R. thigh. *b*. Second injection L. thigh. *c*. Well-marked local œdema (R. thigh). *d*. Œdema from thigh to fore leg (L. side).

*Experiment II.*—The effect of a larger dose of the same products similarly concentrated at 35°–40° C., is shown in Chart II. It represents the effect on the temperature of each of two doses, the second of which was the larger.

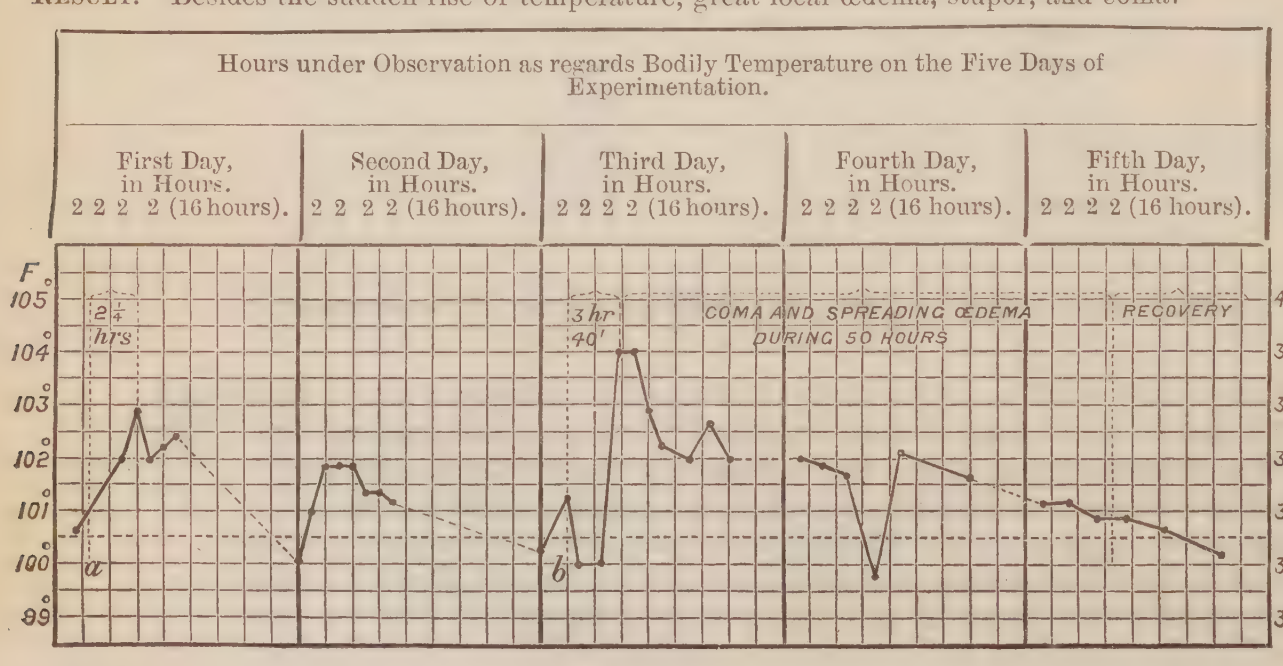
## Chart II.

Guinea-pig weighing 641 grammes.—Amount injected:—

*First dose.*—Albumoses, 0·03 gram.; base, 0·17 gram.

*Second dose.*—Albumoses, 0·06 gram.; base, 0·34 gram.

Result.—Besides the sudden rise of temperature, great local œdema, stupor, and coma.




*a*. First injection. *b*. Second injection.

A rise of temperature occurred, it will be observed, at intervals of $2\frac{1}{4}$ and $3\frac{3}{4}$ hours, respectively after inoculation; and after the second dose, lasted (with exception to be noted) for nearly 48 hours. It is also to be observed that the temperature fell to normal on the day following the second dose, and that this fall was succeeded by a reactionary rise. Coma and spreading œdema were present.

### (b.) *Effect of the mixed products boiled for* 2–3 *hours in an open vessel.*

or boiled in an open vessel.

If the culture filtrate be concentrated at 100° C., the products are still capable of producing a rise of body temperature.

The fever thus produced in guinea-pigs,—as shown in the following table relating to two of these animals (*a* and *b*) weighing respectively 548 and 516 grammes,—commences 2–3 hours after the injection and persists for several hours; but it is not so prolonged as that produced by the unboiled products.

In one guinea-pig, it will be noted, there was a well-marked depression of temperature instead of a rise; a circumstance that has not been observed except with the heated products.

| Date. | Hour. | Time after Injection. | Temperatures of— | | Remarks. |
|---|---|---|---|---|---|
| | | | Guinea-pig (*a*). | Guinea-pig (*b*). | |
| 1890. | | hrs. mins. | | | |
| Dec. 1 - | 9.0 a.m. | — | 98·8° F. | 99·4° F. | Neither animal showed any symptom except the depression or the rise of temperature noted. |
| „ - | 10.0 „ | — | 100° | 99·8 | |
| „ - | 10.20 „ | Injection.* | — | — | |
| „ - | 11.0 „ | 0 40 | 100·4° | 100·4 | |
| „ - | 12.0 „ | 1 40 | 98·° | *102·* | |
| „ - | 1.0 p.m. | 2 40 | 98·6° | *101·8* | |
| „ - | 2.0 „ | 3 40 | 96·4° | *102·8* | |
| „ - | 3.0 „ | 4 40 | 96·6° | *102·8* | |
| „ - | 4.0 „ | 4 40 | 96·8° | *102·4* | |
| „ - | 4.30 „ | 6 10 | 97·° | *101·8* | |
| Dec. 2 - | 9.0 a.m. | 22 40 | 100·4° | 100·4 | |
| „ - | 10.0 „ | 23 40 | 100·2° | 101· | |

* Into guinea-pig (*a*), albumose, 0·052 grm.; base, 0·076 grm.
„ „ (*b*), „ 0·036 „ ; „ 0·056 „

The question as to which of the products, the albumoses or the basic body, was the most active agent in the production of fever was settled by observing the effect of the purified albumoses and of the base in separate experiments.

### (c.) *Effect of the Anthrax Albumoses alone.*

The fever is produced by

Each of two guinea-pigs received 0·09 grm. of mixed proto- and deutero-albumose; the solution having been boiled for 30 seconds before injection in one case, and left unboiled in the other. The effect is shown in Chart III., where for the purpose of contrast the effect, on a third guinea-pig, of a similar dose of purified proto- and deutero-albumose formed in peptic digestion is also exhibited.

## Chart III.

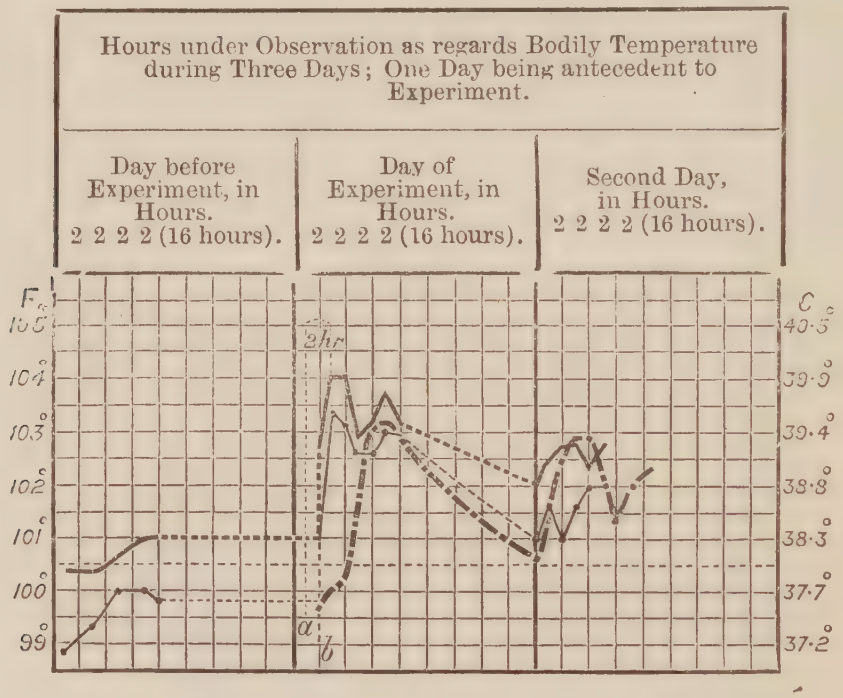
the albumoses,

Upper Thick Line.—Temperature of a guinea-pig weighing 430 grammes, injected subcutaneously with 0·09 gramme *anthrax-albumoses, unheated.* Dose per kilo. of body-weight 0·2 gramme.

Middle Thin Line.—Temperature of a guinea-pig weighing 440 grammes, injected with 0·09 gramme *anthrax-albumoses, boiled* in solution for 30 seconds. Dose per kilo. of body-weight, 0·2 gramme.

Lower Broken Line.—Temperature of a guinea-pig weighing 460 grammes, injected with 0·09 gram. *peptic albumoses, unheated.* Dose per kilo. of body-weight, 0·195 gramme.

No local œdema; no general symptoms, except fever, in any of the guinea-pigs.




*a.* Time of injection of anthrax-albumoses.
*b.* „ „ „ peptic albumoses.

Boiling the solution for a short time appears therefore to have only a slight effect in diminishing the fever-producing activity of the anthrax albumoses. The character of the fever is the same as that described as following the injection of the mixed anthrax products. The animals now in question showed no local œdema and had no symptoms but rise of temperature.

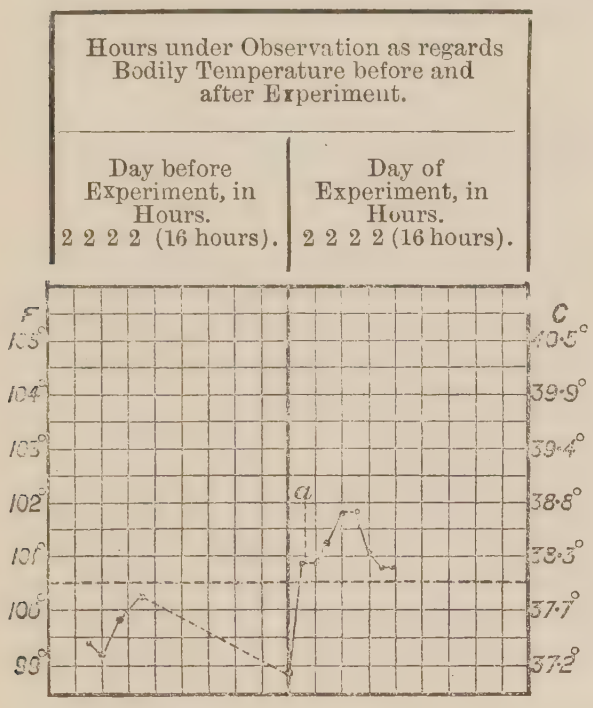
### (d.) *Effect of the Anthrax Basic Body alone.*

not by

The anthrax base caused a slight rise of temperature only, or no rise at all. This is shown in Charts IV. and V.

### Chart IV.

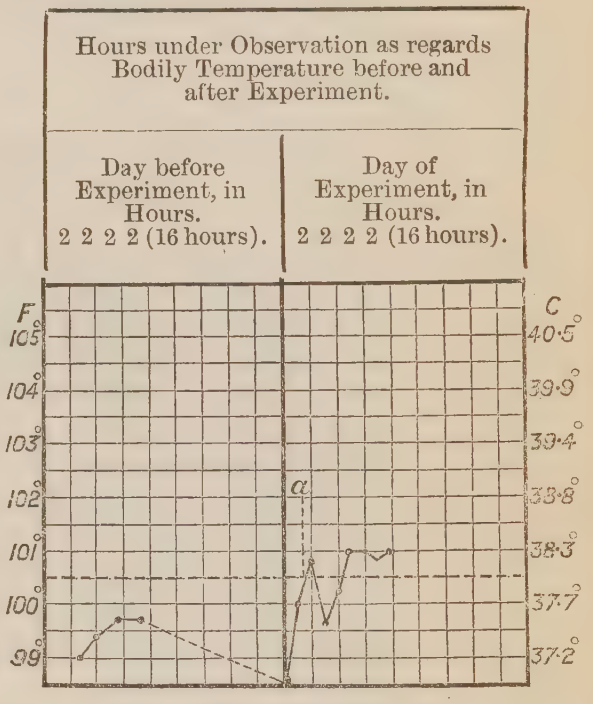
Guinea-pig weighing 450 grammes, injected subcutaneously with 0·08 gramme of the *anthrax base*. Dose per kilo. body-weight, 0·177 gramme.
Local œdema; no general symptoms.




*a*. Time of injection.

### Chart V.

Guinea-pig weighing 586 grammes, injected subcutaneously with 0·129 gramme of the *anthrax base*. Dose per kilo. body-weight, 0·22 gramme.
Local œdema; no general symptoms.




*a*. Time of injection.

It is thus seen that the fever-producing action of the anthrax products belongs almost solely to the albumoses, that is to the proteid precursors of the base; while the local œdema and the coma produced by the mixed products are due rather to the alkaloid than to the albumoses. the alkaloid.

These inferences agree with the results now to be described as obtained from a chemical examination of the tissues of animals dead of anthrax.

### 4. Separation of the Anthrax Products from the Tissues of Animals in which Anthrax had been induced.

No artificial-culture fluid can exactly imitate the natural fluids of the animal body. How widely the composition of broths and other culture media in ordinary use differ from the fluids of the body, I have already insisted on in my report of last year. Although the culture fluid used in those experiments of mine, viz., a mixture of alkali-albumin (made from serum) with serum salts, constituted a fluid closely similar in chemical composition to the natural fluids of the body, it appeared very desirable to have the results confirmed or otherwise by a chemical examination of the tissues and organs of animals that had been made the subjects of anthrax. For this purpose, guinea-pigs, and one sheep were utilized; and the anthrax products when separated from the tissues of these animals, were tested, as before, on mice. Anthrax products from the animal body:

In performing these experiments, the following objects were aimed at:—

1. To produce anthrax disease in the experimental animals by the subcutaneous inoculation of the splenic pulp or blood of an animal (guinea-pig) that had been killed by inoculation of a pure and virulent culture of the bacillus anthracis.

2. To obtain their blood for examination at a time when the disease was well developed: in guinea-pigs, for example, when the local œdema was well marked, and as soon as the first symptoms of sluggishness and stupor were apparent. If the animal, however, died of the induced anthrax, the tissues were examined a few hours after death, before any post-mortem change had occurred.
3. It was considered sufficient for all practical purposes to examine the local lesion, the blood, the spleen, and the liver.

### (a.) *Methods used for the extraction of the Anthrax Products from the Tissues of the experimental Animals.*

how obtained;

The blood on being withdrawn from the experimental animal, was at once mixed with rectified spirit. So too the local lesion, the spleen, and the liver of animals dead of anthrax, were finely divided and mixed with an excess of rectified spirit. In this way all further growth of the bacilli was hindered, and putrefractive changes were prevented.

In these mixtures a search was made for the anthrax albumoses and for the anthrax base, in the following manner:—

The mixture after being allowed to stand for 24 hours or longer, to coagulate most of the coagulable proteids, was filtered, the filtrate thus obtained constituting a watery and alcoholic extract. The residue of tissue was then treated with sterilized distilled water for a further 24 hours, and filtered,—the process being repeated until all soluble matter had been removed.

their separation from the tissues.

*Separation of the proteids.*—All these extracts were evaporated to small bulk in vacuo at 35°—40°C, and the concentrated solution was then thrown into alcohol. The soluble proteids were thus in great part precipitated. But they were not present in sufficient quantity to purify by dialysis; so they were precipitated from solution two or three times, and finally washed with absolute alcohol and dried.

*Separation of the base.*—The anthrax base is present (free or combined) in the alcoholic filtrate after removal of the proteid. It is separated by making the liquid strongly alkaline with $K_2CO_3$, and saturating with the salt. The alcohol carrying the base with it floats on the surface of the watery liquid saturated with $K_2CO_3$.

This alcoholic solution is evaporated to dryness at 40° C, leaving a yellow residue mixed with $K_2CO_3$. The residue is extracted with absolute alcohol (sp. gr. 0.796), the solution filtered, and poured into a large excess of ether. As a result the ether becomes cloudy, and after a short time deposits the base as a yellow amorphous mass. The ether is next poured off, the precipitate washed with ether, and dissolved in alcohol and filtered. In this solution there is still some fat, fatty acid, and $K_2CO_3$, though most of the fat has been removed by the ether; the remainder together with the fatty acid has to be removed by chloroform. I have, however, found it practically impossible to separate the base completely from the $K_2CO_3$. The process of drying it, dissolving it, and filtering in a desiccator, has been repeated 20 times without removing all the mineral matter. The importance of removing most of the potassium salt is evident, as a large quantity, if present, would vitiate the results of the investigation of the physiological action of the basic body. This point will be referred to later.

To proceed now to an account of the result of actual examination of the anthrax tissues of the guinea-pig and the sheep:—

(b.) *Experiment on Guinea-pigs.*

Twenty-eight full-grown and healthy guinea-pigs were inoculated subcutaneously with the diluted splenic pulp of a guinea-pig just dead of anthrax. 29 hours afterwards, 12 of the animals were dead, and most of the remaining 16 were ill. The blood of these 16 was obtained by severing the vessels of the neck. It coagulated almost immediately, though not perhaps quite so instantaneously as does the normal blood of the guinea-pig.

All these animals showed the lesions of anthrax: a well-marked local œdema, and an enlarged and congested spleen. Products from the guinea-pig:

Their tissues were examined in the manner just described.

I. As to Proteids obtained from their tissues—

*α. In the local lesion.*—Most of the proteids in the local œdema consisted of the ordinary proteids of pathological exudations, readily coagulated by alcohol. But the following proteids not readily coagulable, or indeed uncoagulable, were also found:—Namely, hetero-albumose (or similar proteid), and deutero-albumose.

The *Hetero-albumose* amounted to 0·126 gramme* and gave the following re-actions:—Readily soluble in saline solution (0·75 per cent. NaCl). The solution gives a doubtful biuret reaction with $CuSO_4$ and KHO. It is precipitated by $HNO_3$, the precipitate being soluble on heating, and reappearing on cooling. It is also precipitated by boiling, the coagulum being partly soluble in 2 per 1000 NaHO. Owing to the small quantity of material, it was impossible to decide the exact nature of this body. albumoses,

The *Deutero-albumose* amounted to 0·194 gramme. It showed yellow in solution, giving a bright biuret reaction, and was precipitated by saturation with NaCl in an acid solution.

*β. From the spleen.*—0·18 gramme of albumoses was obtained, chiefly proto-albumose with some deutero-albumose.

*γ. From the blood and liver.*—No albumoses were obtained. The proteids of the blood consisted solely of coagulated proteid.

II. As to Alkaloid obtained from their tissues— alkaloid.

| | |
|---|---|
| From the local lesion - - - | 0·188 |
| From the spleen - - - - | 0·116 |
| | 0·304 gramme. |

The alkaloid was also present in the blood in appreciable quantities;† but in the liver traces of it only were found.

III. As to Fat and Fatty Acid obtained from their tissues— Fatty acid.

The fat separated from the crude alkaloid presents the ordinary physical character of fats, and is non-poisonous. With the fat is a fatty acid, readily soluble in chloroform, and which has so characteristic an aromatic smell that its presence can be readily detected in pure cultures of the bacillus in artificial serum, as well as during the preparation of the alkaloid from the tissues of the guinea-pig and sheep. Whether it be formed from the fat, or by the splitting up of the proteid molecule under the action of the bacillus, there is no evidence at present to decide.

* The weights are given to show the relative quantity of proteids to the base found. They are not of any absolute value.

† Most of the blood extract unfortunately became putrefactive.

The important outcome of the above procedures is the circumstance that :—*The alkaloid separated from the tissues of these anthrax guinea-pigs, gave the same reactions as did the alkaloid obtained from artificial cultures of the anthrax bacillus.* It was an amorphous yellow substance, with the same faint aroma as the artificial alkaloid, soluble in absolute alcohol, amyl-alcohol, and in water ; insoluble in ether, chloroform, and benzene. It was precipitated from watery solution by phospho-tungstic and phospho-molybdic acids and by mercuric chloride, but was not precipitated by Mayer's solution.

The physiological action of this alkaloid on mice was found to be as follows :—

| Weight of Mouse, in grammes. | Dose, in grammes, of Alkaloid injected. | Dose per Kilo. Body-Weight of Mouse. | Results. |
|---|---|---|---|
| 19 | 0·025 | 1·3 | No symptoms. |
| 19 | 0·044 (from spleen). | 2·3 | Death in under 17 hours. Large local œdema with ecchymoses. Spleen large, dark, congested. |
| 21 | 0·101 | 4·8 | Comatose in 3 days. Coma lasted 6 hours till death. Local ecchymosis. No œdema. Spleen small, dark, congested. Other organs normal in appearance. |

### ($b^2$.) *Experiment on a Sheep.*

Products from the sheep :

A full-grown and healthy sheep was inoculated in the thigh (by Dr. Klein) with the splenic pulp of a guinea-pig, that had been killed by a culture of the bacillus obtained from the natural anthrax disease in the cow. This sheep died in 36 hours. The *post-mortem* was made six hours after death while the body was still warm. Gelatine-tube cultivations made of the heart's blood afforded pure and virulent cultures of the bacillus anthracis.

The blood was found dark and fluid. The spleen was greatly enlarged and congested ; the liver was deeply congested.

The local lesion, blood, and spleen were duly examined.

I.—As to Proteids obtained from the tissues—

Most of the proteids in the local œdema consisted of coagulable proteid, as was the case with the guinea-pig.

albumoses,

The uncoagulable proteids consisted of proto- and deutero-albumose, giving the reactions, already described, of the anthrax albumoses.

The quantities found were in the following proportions :—

| | |
|---|---|
| Albumoses from local lesion - - | 0·167 |
| „ „ spleen - - | 0·191 |
| „ „ blood (chiefly deutero-albumose) - - - - | 0·455 |
| | 0·813 gramme. |

The physiological action of these albumoses was tested on a mouse.—January 14th, 1891. 12 a.m. Thus—into a mouse weighing 19 grammes, 0·273 gramme albumose from the blood was subcutaneously injected. The animal was ill in one hour, and died in coma in $2\frac{1}{4}$ hours.

There was large local œdema and congested kidneys; the spleen was normal.

II. As to Alkaloid obtained from the tissues—

*This had the same physical properties, and gave the same reactions as regards solubility and precipitation, as the alkaloid obtained from artificial cultures, and from the tissues of the guinea-pig.*

The following quantities of it were obtained :—

| | | |
|---|---|---|
| From the local lesion - - - - | 0·1346 | alkaloid. |
| ,, ,, blood - - - - | 0·6430 | |
| ,, ,, spleen - - - - | 1·2080 | |
| | 1·9856 gramme. | |

The physiological action of this alkaloid on mice is shown in the following table :—

| Weight, of Mouse in Grammes. | Dose, in grammes, of Alkaloid injected. | Dose per Kilo. Body-Weight of Mouse. | Result. |
|---|---|---|---|
| 22 | 0·022 | 1·00 | No illness. |
| 29 | 0·043 | 1·48 | Sluggish for 3 days ; recovered. |
| 22 | 0·077 | 3·50 | Sluggish ; recovered. |
| 14 | 0·060 | 4·3 | In a state of stupor in 4 hours ; partial recovery in $22\frac{1}{2}$ hours. Killed :—Well marked local œdema ; congestion of spleen and kidneys. |
| 15 | 0·114 | 7·6 | Comatose in $2\frac{3}{4}$ hours ; death in coma in $5\frac{1}{4}$ hours. Large amount of clear local œdema. Cortices of the kidneys deeply congested ; spleen and other organs normal to naked eye. |

In some of the animals which recovered, a small sore at the site of inoculation was noticed after five days. It is doubtful whether or not this sore was due to the small amount of $K_2CO_3$ present.

### (c.) *The Condition of the Alkaloid, whether free or combined in the Tissues of the Experimental Animals.*

Condition of alkaloid.

The first filtrates obtained, in the manner above described, from the tissues of the guinea-pig gave the following reactions to test paper :—The filtrate from the local lesion was nearly neutral, perhaps slightly alkaline ; those from the blood and spleen were distinctly acid. The reaction of these filtrates suggested that the alkaloid had been in a state of combination in the body. This was investigated in the following manner :—The tissue extract was evaporated to dryness and extracted with absolute alcohol. The presence of the *free* alkaloid in the alcoholic extract was then determined by drying, re-dissolving, and filtering, and finally precipitating with ether. If there appeared evidence of presence of the alkaloid by the formation of the characteristic yellow deposit in ether, this was purified and subjected to the tests for the aklaloid already described.

As regards the alkaloid *in combination*, the residue of the filtrate of the tissue, after complete exhaustion with alcohol, was made strongly alkaline to decompose any salt of the alkaloid present, and after evapora-

ting to dryness was extracted with alcohol. This extract was purified as before, and the tests for the alkaloid applied to it.

The following are the results obtained by the above processes as regards the animals of experiment:—

Summary.

1. In the local lesion of the sheep the alkaloid is both free and combined.

2. In the spleen of mice, guinea-pigs, and sheep, it is also both free and combined; but the greater part is in a state of combination.

It has so far been found impossible to determine the nature of the salt of the alkaloid present.

## General Conclusions.

Conclusions.

1. It has been shown by these experiments that the chemical products formed in culture by attenuated and by virulent bacilli anthracis are the same. There is indeed difference between bacilli of the two sorts in their rate of growth in culture and in the amount of chemical products formed by them; these being respectively more rapid and greater in the case of the virulent bacillus.

2. That a lethal dose for mice of the mixed anthrax products is 18 milligrammes of the albumoses and 28 milligrammes of the alkaloid.

3. That the chemical products formed by the bacillus in the body of an animal made the subject of anthrax, are the same as those produced by the same bacillus outside the animal body, namely, in culture medium such as the artificial serum already described. These products are albumoses,—anthrax proto- and deutero-albumose,—and a specific base provisionally called an alkaloid. And they are the *only* poisonous products which could be obtained from the tissues of animals dead of anthrax.

4. The albumoses are to be looked upon as the proteid precursors of the alkaloid. They, and not the alkaloid, are the active agents in producing the fever. This they can do in small doses without producing a local lesion or any general symptoms. In large doses, however, the albumoses do produce local œdema and coma.

To the alkaloid is to be ascribed the spreading œdema, and especially the coma. In some cases it produces a slight rise of body temperature; in other cases it does not affect it.

5. It is the alkaloid which produces death. The large amount of it found in the tissues of the sheep, compared with the amount of albumoses, demonstrates this.

## No. 5.



### Preliminary Report on certain of the Conditions determining Insusceptibility; by W. H. Hamer, M.A., M.D., B.Sc.

Much time and labour have been devoted of late years to a study of the conditions which determine insusceptibility of the animal body to one and another infection. As is well known, certain bacteria introduced within the tissues of an experimental animal fail to maintain their existence within the host thus provided for them, whereas there are other bacteria (as for instance pathogenic microbes) that not only continue alive in the tissues of the experimental animal, but also reproduce themselves there and multiply abundantly. What is it that determines in the one case the destruction of the bacteria, in the other their development and multiplication?

Diverse views of Insusceptibility.

The answer to this question is being worked out at the present time from two entirely different points of view. The one provisionally regards certain vitalised elements of animal tissue, phagocytes, as possessed of germicidal function, whereby they consume (actually eat up) invading microbes; whereas the other would refer the resistance of living animal tissue to invasion of the above sort, to a quasi-poisonous property of non-vitalised (chemical) constituents of such tissue, either natural to the tissue or superadded thereto.

Cell theory versus chemical elements of tissue.

Thus Metschnikoff and others laying stress upon the fact that bacteria are so often found within the substance of leucocytes, maintain that the organisms so situated have been eaten up by the cells, and are in process of destruction. While on the other hand Buchner, Nuttall, and others have shown how potent is the germicidal action of animal fluids entirely apart from cells, and it is suggested by them that an important factor in determining immunity is the presence of particular chemical substances in the animal tissues.

Cell theory to be put to test.

In the present research the former of these aspects of the question has alone been dealt with. A study has been made of the phenomena occurring at the site of inoculation in the case of certain bacteria, with the object, in particular, of noting the part played by cells in hindering the development, or in bringing about the destruction of the organisms introduced.

In the first place, it is necessary to speak of the kind of diseased condition which has been investigated. Metschnikoff has laid it down as a law that "the more malignant the micro-organism, the rarer is its "presence within the phagocyte;" he instances chicken cholera, hog cholera, anthrax, and septicémie vibrionienne as examples of diseases of peculiarly rapid course in which "bacteria are only very exceptionally "to be found within the cells, but remain free in the neighbourhood "of their introduction, and thence invade the blood," and he goes on to state, in illustration of *time* as a necessary element in germicidal

action of the cells on invading bacteria, that "in general a well-"marked phagocytosis is associated with diseases presenting an essen-"tially chronic development;" that "it is in affections such as "tuberculosis, leprosy, rhinoscleroma, glanders, that the specific "bacteria are most readily taken up by the phagocytes;" that "it is "here, at the seat of the disease, that we meet with innumerable "macrophages—epithelioid cells in which lie the individual micro-"organisms."

Of course the presence of bacilli in a giant cell does not prove that the cell has destroyed or is destroying the bacilli, but it would seem in the first instance profitable to inquire whether the generalisation from particular instances made in the above passage is correct, and to investigate the justice of formulating any general law with respect to the presence of bacteria in cells in the case of diseases of chronic and local development.

Such diseases might be assumed, if the doctrine of phagocytosis be admitted, to present an exceptionally favourable field for studying the eating-up of bacteria by cells. But in order to prove from the phenomena manifested in such diseases, the existence of phagocytosis, it is first necessary to ascertain accurately what the said phenomena are.

Dr. Klein having isolated from pork a variety of the proteus organism, closely agreeing with Proteus vulgaris in its microscopic and cultural characters, inoculated cultures of this organism into guinea-pigs and mice. As a result, local mischief was set up, from which in some instances the animal recovered, while in other cases, after the lapse of some 10—14 days, a fatal termination ensued. Cover-glass specimens made from material taken from the diseased area in such animals, showed large numbers of the proteus organism and also large numbers of leucocytes. But the bacteria were almost invariably free; it was most exceptional to find leucocytes including organisms, and in the few instances of this occurrence which could be discovered, the leucocyte took the stain faintly, and no nucleus was visible. Here then was a disease of slow and local development in which the presence of bacteria in cells was a phenomenon conspicuous by its rarity. This striking fact suggested a further study of the conditions met with in the neighbourhood of the site of inoculation in these cases, and the inquiry was extended to the areas of local mischief produced by the Middlesbrough pneumonia bacillus in guinea-pigs, and then to the localised tumours resulting in the same animal from the subcutaneous inoculation of the diphtheria bacillus.*

Slow and local infections most suitable for study.

### A.—*Experiments with the Proteus Organism.*

Proteus organism

The following animals were made the subjects of examination :—

(i.) Guinea-pig, inoculated July 4, died July 9; local œdema produced.

(ii.) Mouse, inoculated July 9, died July 23; large necrotic area at site of inoculation.

(iii.) Guinea-pig, inoculated July 14, died July 24; necrotic patch at site of inoculation.

(iv.) Guinea-pig, inoculated July 10, killed July 28; ulcer at inoculation site.

(v.) Guinea pig, inoculated July 14, killed July 28; an enlarged gland just above site of inoculation.

* All animals mentioned here belonged to the experimental series carried out by Dr. Klein in his investigations of these different microbes.

The two animals last specified were, at the time of being killed, apparently recovering from the effect of the inoculation. Thus the ulcer in No. (iv.) had remained stationary for some days, and the animal was quite lively and active. Cultures made from the heart blood of Nos. (iii.) and (iv.) remained sterile.

In all cases except the last, No. (v.), cover-glass specimens made with material from the diseased area showed large numbers of free proteus organisms and plenty of leucocytes; but it was very rare to find any cells containing organisms in their interior, and no giant cells could be found.

not found within tissue cells.

Sections of the diseased tissue showed in all cases except No. (v.), numerous cocci on the surface and accumulations of cells in the depth. These cells were for the most part devoid of organisms, but in some instances granules were seen in the interior of faintly staining leucocyte-like bodies which presented no appearance of a nucleus, bodies that were therefore taken to be degenerate cells. The intermuscular capillaries were crowded in No. (i.) with cocci forms (*see* fig. 1, Plate X.); in Nos. (ii.), (iii.), and (iv.) the cocci and short rods appeared for the most part in clumps, and since they held the stain tenaciously these masses could be readily differentiated by Gram's method from the surrounding tissues. Such clumps were from 5 to 10 or more times the diameter of a leucocyte, and were situated either in necrotic tissue or were lying more deeply in lymph spaces; they were certainly not included in giant cells.

In the gland of No. (v.) no organisms could be discovered, indeed in the case of this animal recovery seems to have been practically complete. Sections of the diseased tissues of No. (iv.) were particularly striking; large masses of organisms being seen, lying quite free from cells and showing up in marked contrast to the counterstained surrounding tissue.

### B.—*Experiments with Bacillus Pneumoniæ.*

Bacillus pneumoniæ.

In the case of the pneumonia bacillus greater difficulty was encountered in securing the exact degree of virulence required in the culture material used. Some guinea-pigs remained unaffected by the inoculation, and on the other hand, it was a condition of experiment to produce a chronic not an acute disease. The two cases to be referred to were those in which this result was best attained.

(i.) Guinea-pig inoculated October 8th, developed œdematous swelling; killed October 11th.

(ii.) Guinea-pig inoculated October 8th, developed brawny thickening; killed October 13th.

similarly not observed in the cells.

In each case cultures were made with material obtained from the œdematous area, and these proved to be pure cultivations of the pneumonia organism. In No. (i.), cover-glass specimens yielded similar evidence to that obtained in the previous proteus cases. In No. (ii.), no micro-organisms could by this method with certainty be identified. Sections through the diseased tissues of No. (i.) showed enormous numbers of coccus and short-rod forms, but yielded no evidence of phagocytosis. In No. (ii.) the number of organisms present in sections was small, a few clumps were, however, detected; in two cell accumulations in a section the leucocytes were devoid of organisms.

### C.—*Experiments with Bacillus Diphtheriæ.*

Bacillus diphtheriæ,

In the case of the diphtheria bacillus a local and chronic development of disease was much more easily secured, and the action of this

organism was investigated in a considerable number of guinea-pigs. In the animals inoculated an œdematous thickening developed in the inguinal region at the site of introduction of the bacilli. If death occurred early no constant post-mortem appearance was noted beyond marked congestion of the suprarenal capsules; but if on the other hand the animal lived many days after inoculation, a large firm-textured local tumour was developed, and it was usual to find evidence of fatty degeneration in the liver and kidneys, and sometimes pleural or peritoneal effusion occurred. Cultures made from the heart blood or from internal organs, proved uniformly sterile; but from portions of the locally induced tumour pure cultivations of diphtheria bacilli were almost invariably obtained. These results are in accordance with what has been described by Löffler and others, and with what was stated by Dr. Klein in his report of last year.

The readiness with which such pure cultivations of the true diphtheria bacillus were obtained from the local tumours 15, 18, 20, and even 34 and 35 days after inoculation, was very striking. All these cultivations were made in gelatine tubes kept at a temperature of 20° C. In marked contrast to this facility of growing the bacili in cultures, was the rarity with which the organism could be demonstrated in cover-glass preparations from the same tumour. In fact in only three instances were such preparations obtained which showed undoubted diphtheria organisms in considerable numbers. In these three instances the bacilli were always free and not contained in cells.

dissociated from the cells.

Again in sections of the local tumours the bacilli were but sparely distributed. In cases of early death no organisms indeed could as a rule be detected, in tumours of longer duration on the other hand the following appearances were observed. In the midst of the dense tumour tissue was a non-stain-retaining necrotic area completely devoid of cells, but containing masses of bacilli. These masses hold the stain and show up well against the counter-stained background. The bacilli therein show a tendency to grow into threads and present in places a granular appearance. (Compare in this connexion the description given by Dr. Klein, in his report of last year, of the distribution and nature of the bacilli in the diphtheritic tumour of the cow.) Around this inner necrotic area were grouped masses of leucocytes constituting an inflammatory zone. These leucocytes never contained distinct rods, but in some granules were very exceptionally to be seen. Outside the inflammatory zone the morbid tissue gradually passed into normal tissue, in this region no micro-organisms could be detected.

The limited area in which the presence of bacilli was noted was in striking contrast to the magnitude of the lesion produced by them. In a few cases the presence of large granules in the neighbourhood of the clumps of bacilli was noted. These granules lay free, were much larger than ordinary cocci, and were brought out when present by several different methods of staining. Their nature is uncertain.

As regards methods of staining the clumps of bacilli, Gram's was found unsuitable; many sections were stained in Löffler's alkaline blue and decolourised with acetic acid and alcohol; the clumps can, however, be stained with the ordinary Weigert solutions of aniline dyes.

The following is a list of the guinea-pigs experimented on with bacillus diphtheriæ, and of the results obtained :—

| Number of Animal. | Day on which Death occurred after Inoculation. | Presence of Bacilli in Cover-glass Preparations from the material of the Local Tumour. | Growth, if any, obtained on Culture. | Presence or Absence of Masses of Bacilli in midst of Necrotic Tissue. |
|---|---|---|---|---|
| i. | 2nd | Nil | Typical | Nil. |
| ii. | 9th* | Nil | Nil | Nil. |
| iii. | 3rd | ? | - | Present. |
| iv. | 8th | - | Typical | Present. |
| v. | 9th | - | „ | Sections not made. |
| vi. | 18th | Nil | „ | Present. |
| vii. | 2nd | - | „ | Sections not made. |
| viii. | 2nd | Nil | „ | Do. |
| ix. | 3rd | - | „ | Do. |
| x. | 7th | Present in small numbers. | „ | Present. |
| xi. | 7th | Nil | Nil | Sections not made. |
| xii. | 13th | Present | Typical | Present. |
| xiii. | 8th | ? | Doubtful | Sections not made. |
| xiv. | 4th | Nil | Nil | Present. |
| xv. | 15th | Nil | Typical | Present. |
| xvi. | 11th | Nil | „ | Nil. |
| xvii. | 20th | Nil | „ | Present. |
| xviii. | 9th | Nil | „ | Nil. |
| xix. | 8th* | Nil | „ | Present. |
| xx. | 35th | Present | „ | Present. |
| xxi. | 34th | Nil | „ | Present. |
| xxii. | 6th | Present | „ | Present. |
| xxiii. | 14th | Nil | „ | Present. |

* Signifies that the experimental animal was killed on that day.

The fact that the existence of clumps of bacilli lying in the midst of non-stain-retaining necrotic tissue (*see* figs. 2 and 3, Plate X., and figs. 4 and 5, Plate XI.) was demonstrable in 13 out of 17 of the cases in which sections were made, seems to show that this is the ordinary condition which exists in these diphtheria tumours. That a negative result was obtained in some few cases, is readily explicable

considering how scanty and local the development of the bacteria appears to have been in all the tumours. The observed accumulations of leucocytes around the borders of the several necrotic areas, at some distance from the clumps of bacilli, are not necessarily the direct result of the presence of these organisms; they may just as well be due to cell exudation induced by the chemical products of the life processes of the bacilli, a "chimiotaxie positive" exerted upon cells by these chemical products, to adopt the modern phrase.

Summary.

At all events the conditions observed (which are figured in the illustrations to this report) lend no support whatever to the doctrine of Phagocytosis; rather they are in direct opposition to the conclusions drawn by Dr. Ruffer (Brit. Med. Journal, July 26, 1890) from his study of the microscopical appearances in human diphtheria. Dr. Ruffer says, "the diphtheritic membrane is a battlefield for amœboid "cells and the pathogenic microbes of diphtheria." If the necrotic area in the tumour produced in the guinea-pig is to be regarded as a battlefield, it must at least be admitted that Dr. Ruffer's combatants are not at close quarters there.

## No. 6.



### Observations on Pyogenic Organisms; by Frederick W. Andrewes, M.B., M.R.C.P.

It has been established for many years that acute abscess formation and phlegmonous inflammation, depend on the presence in the affected tissues of micro-organisms, chiefly staphylococcus aureus and albus, and streptococcus pyogenes. Certain irritating substances, such as croton oil, turpentine, and Koch's tuberculin, have been shown, it is true, also to cause suppurative action; but this is rather of theoretical interest than of practical importance, since it remains true that in surgical practice such processes are almost invariably due to infection by extraneous living organisms.

The same has not been shown to be so uniformly the case in chronic or "cold" abscesses, though it by no means follows that failure to demonstrate the existence of micro-organisms in a given abscess proves their absence at all periods in the history of the case. Such failure may be due sometimes to their death, sometimes to the imperfection of the means of cultivation at our disposal. Many well-known species of bacteria have never yet been artificially cultivated; and new culture methods might very possibly reveal to us a host of forms of lower organisms of which we are now in total ignorance.

In a bacteriological investigation, undertaken by me during the past year, of suppuration and of phlegmonous and other inflammation in the human subject, the above considerations have been duly held in view; and my object has been to isolate and study each and every micro-organism present in the diseased tissues under observation. The media employed were broth, Agar-agar, and gelatine, the last-named being usually incubated at a temperature of 20° C. and the two former at 37° C.

### A.—Chronic Suppuration.

The following were the only chronic abscesses which I investigated; and the results are in complete accordance with what was previously known.

*Case* 1.—A man of 44 had suffered for twenty-five years from pain in his right loin, when he fell and struck his back; the pain was thereafter more severe, and six weeks after the injury he noticed hæmaturia. A little later pus occurred in the urine, with increased severity of pain. Five months after the injury an incision was made in his loin and a large abscess found in the substance of the kidney. This was opened, but no stone found either then or at a subsequent exploration. At the time of the operation a number of cultivations were, with due precautions, made from the pus, on Agar-agar, on gelatine, and in broth. In stained preparations of the pus itself no trace of any organisms was visible. Five out of six cultures remained absolutely sterile, and only two colonies, obviously contaminations, appeared in the sixth. It may thus be affirmed that no evidence of the presence of micro-organisms could be found in this case of renal abscess of some five months duration. The subsequent history of the case is interesting. After the second exploration for stone, the patient developed irregular fever, and fluctuating swellings appeared in various parts of his body; pyæmia was suspected, but all the swellings disappeared without suppuration, and he

completely recovered. Any infective process that may have occurred depended clearly on the second operation and not on the primary disease.

*Case* 2.—A girl of eight suffered from hip disease of two years standing. For three or four months she had had evidence of suppuration in the joint. An incision in the gluteal region disclosed pus in the acetabulum; about three ounces escaped, thin in consistency and containing flakes of lymph. Stained preparations showed no tubercle bacilli and no other organisms. Four cultures were made from the pus at the time of the operation, on gelatine and on glycerine agar-agar. No growth occurred in any of them, though the Agar tubes were kept at 37° C. for three weeks and more.

*Case* 3.—A man who had been in India but had never had dysentery, developed a hepatic abscess which pointed in the right hypochondrium. The abscess being opened, a large amount of grumous pus escaped, and from this a number of cultures were made. No organisms could be found in stained preparations of the pus. A careful search was also made for amœbæ in the fresh pus; granular cells very much larger than pus corpuscles were here and there present, but no movements could be detected in them though they were carefully watched. Their nature was therefore doubtful, though the known occurrence of amœbæ in tropical abscess makes it probable that they were such. All cultures from the pus remained sterile.

### B.—Acute Suppuration.

In one acute case I failed altogether to get any growth of organisms though they were undoubtedly present in the pus. Its history was this:—

*Case* 4.—A child of one year old developed acute periostitis of the femur after a fall on the knee. When the disease was only two or three days old an incision with a sterilised knife was made down to the bone, and a small quantity of sweet pus let out. Five cultures were made from it with due precautions, on Agar-agar and gelatine. No single colony appeared on any one of them, though they were incubated for some weeks. Nevertheless stained preparations of the pus showed numerous organisms, mostly cocci, in pairs, with some rods. I am unable to say to what species they belonged, and am quite unable to account for their failure to grow, since the case being recent they must needs have been active and virulent.

In every other case of acute suppuration I have never failed to find micro-organisms.

Since Ogston's researches, published in 1880 and 1881, the distinction between the respective pyogenic actions of staphylococcus and streptococcus has been clearly recognised. He showed that the former tended to produce a localised suppuration, not specially spreading along the lymph-tracts, but melting down, as it were, all the tissues before it. Whereas the latter gave rise to a more spreading and erysipelas-like inflammation or cellulitis, extending itself especially along the path of the lymphatics. He found too that this clinical distinction was supported by microscopic observation; and that whereas the staphylococcus spread in cloud-like masses through almost all tissues alike, the streptococcus crept in chains amongst the tissue elements along the lymph spaces. The resemblance of the phlegmonous cellulitis caused by streptococcus pyogenes to true erysipelas, caused for a time some confusion, especially since the streptococcus of erysipelas so closely resembles streptococcus-pyogenes. Fehleisen, however, has clearly separated off the erysipelas organism; he has shown that it occurs chiefly in the superficial layers of

the corium at the spreading margin of the disease; and slight, though very slight, differences have been shown to exist between cultures of the erysipelas coccus and streptococcus pyogenes. The main proof, however, of the correctness of Fehleisen's observations lies in the artificial production of genuine erysipelas in the human subject by inoculation with pure cultures of his streptococcus.

## C.—Erysipelas.

It was my intention to compare cases of true erysipelas with phlegmonous cellulitis, with a view to ascertain, if possible, whether the distinction between the two streptococci was a constant one. But this intention was frustrated by difficulties that I have not been able to surmount. The only means of obtaining the erysipelas organism is by removing fragments of skin from the growing edge of the affected area, and I have not found either surgeons or patients willing to have them removed. In one case only did I succeed in getting permission to remove a piece of skin from a case of facial erysipelas.

*Case* 5.—Facial erysipelas involving the right side of neck. On the fourth day I unfortunately found that the temperature had fallen to normal, and the sharp edge of the disease had vanished. The neck was covered with zinc oxide and starch, and was very difficult to clean; nevertheless a piece of skin was taken where the red margin had been visible the day before, the skin having been previously cleansed as far as possible. The fragment was treated in the orthodox way by immersion in melted gelatine. I obtained from it, however, only an immense number of colonies of a white staphylococcus, which liquified gelatine very slowly. No streptococci appeared at all. I imagine that the staphylococci were contaminations derived from the imperfectly cleansed epidermis; I have again and again met with them in cultures from blood drawn from the finger.

With streptococcus erysipelatos obtained from Berlin I was not more successful. Some cultures were brought over by Mr. E. C. Bousfield, and were said to be virulent, but when inoculated on a rabbit's ear no result followed; nor was I in any way able to distinguish between the streak sub-cultures I made therewith and similar cultures of streptococcus pyogenes.

## D.—Phlegmonous Cellulitis.

I investigated several cases of phlegmonous cellulitis, mostly following poisoned wounds, and had no difficulty in obtaining streptococcus pyogenes, sometimes in pure culture and in great abundance. The chief cases are as follows:—

*Case* 6.—A young girl suffered from a lachrymal abscess, secondary to ciliary blepharitis. Pus eventually extravasated about the inner canthus of the eye, and into the tissues of the cheek. When she was first seen by me there was diffuse cellulitis of the lower eyelid and cheek, the redness of which was not sharply outlined; the swelling closed the eye. After thoroughly cleansing the skin, an incision was made below the inner canthus, letting out pus and blood. The child made an uninterrupted recovery.

A drop of the pus was transferred at the time of the operation, with a sterile wire, to some well-boiled salt solution, and from this a series of cultivations were made on gelatin, Agar-agar, and in broth. In two

days a great number of colonies had appeared on the gelatin, and there was abundant growth in the broth. All the colonies consisted of streptococcus pyogenes; no other organism was present, even as a contamination. On Agar-agar at 37° C. they grew with difficulty, sometimes not at all.

*Case* 7.—A young man scratched his forefinger with a nail from a horseshoe. Three days later he had pain up the forearm, followed by swelling and redness. On the fifth day there was diffuse swelling, redness, and tenderness of the whole hand and forearm nearly up to elbow; the redness was not very sharply outlined, nor did it specially follow the course of the superficial lymphatics. There was a little suppuration about the first phalangeal joint of the forefinger, at the site of the injury. Temperature 100° F.; no rigors and little constitutional disturbance.

After cleansing the skin, the suppurating spot was incised, and a drop of the pus transferred to sterile salt solution. From this, cultures were made. Numerous colonies appeared, all of streptococcus pyogenes, which, as before, would not grow readily on Agar-agar at 37° C. No other organism was present.

*Case* 8.—A boy of 13 received an injury to the hand, which was followed by cellulitis and suppuration of the dorsum of the hand. It was treated by incision and poulticing. Later, suppuration occurred in front of the wrist joint, presumably in the tendon sheaths. This was incised, and much pus escaped. A drop of the pus was put in sterile salt solution as before, and cultures made. On the gelatine a few colonies of streptococcus pyogenes appeared, but they were far less numerous than in the preceding cases. No other organism appeared on the gelatine. But the broth tube contained an abundant growth of a coccus, differing from streptococcus and growing much more luxuriantly on solid media. It was probably a contamination, but I am not able to refer it to its species.

*Case* 9.—A young man scratched his little finger; pain up the arm followed, with some swelling over the cubital lymphatic gland. After a fortnight he was admitted into hospital with lymphangitis of the arm, red streaks running up to the elbow. Later the hand and forearm became uniformly swollen, red, and tender, to above the elbow, and just over the cubital gland was a redder and more swollen patch. The latter was incised, but no pus came out. Cultures were, however, made from the blood and serum which exuded. All proved sterile, not a single colony appeared in any. The cubital gland subsequently suppurated, and the patient completely recovered.

*Case* 10.—A man wounded his cornea; destructive suppuration of his eye ensued, and the contents of the globe had to be removed. Later there was cellulitis of both eyelids, the upper lids being extremely swollen and red. Incision let out only blood and serum; some of this was put in sterile salt solution, and cultures were made; they all proved sterile, as in the last case.

### E.—Empyema.

In a case of empyema I isolated from the pus a streptococcus which appeared different from streptococcus-pyogenes.

*Case* 11.—A child that had been ill for two months, was found to have a large empyema, which was opened by free incision. The pus was sweet, and stained coverglass preparations showed that it contained numerous organisms, dumb-bells and chains of cocci. Seven cultures were made from the pus, but in only one, an Agar-agar tube kept at 37° C., did any growth occur. One or two small greyish white

colonies appeared hereon after the lapse of a week, and were found to consist of a streptococcus with marked disparity in the size of its component units, some being three or four times as large as others; in some places groups of these large forms were present. A similar disparity had been noticed in the cocci in the original pus. I was unable to grow this streptococcus in subcultures, and I am inclined to think that, the pus being old, the organisms in it were dead or dying at the time it was evacuated.

## F.—Pyæmia.

I had an opportunity of investigating a single case of pyæmia.

*Case.*—A man who was the subject of interstitial nephritis, and who was proved to have one kidney in a state of cystic degeneration, developed some swelling of the neck which was at first supposed to be angina ludovici. He was seized with laryngeal obstruction which necessitated tracheotomy. A few days later irregular pyrexia set in, and he died with symptoms of pyæmia. There was at no time any reason to suppose that he had diphtheria. At the post-mortem there was found (besides the renal and cardio-vascular changes of interstitial nephritis) old and recent pericarditis, with flakes of semi-purulent lymph. Also recent pleurisy with semi-purulent lymph. Some tiny abscesses were found beneath the capsule of one kidney, the other being cystic. The lungs were engorged and œdematous, with small sub-pleural hæmorrhages. The larynx was pervious and natural. The tracheotomy wound was foul.

I made cultures in the post-mortem room, with such precautions as were possible, from,—the heart blood, the pericardial pus, the lung tissue, and the kidney abscess. As might have been expected in cultures made in the post-mortem room, a number of contaminations occurred. Several colonies of staphylococcus pyogenes aureus grew from the pericardial pus, but the most interesting organism obtained was a bacillus very closely resembling the diphtheria bacillus. It was present in the heart blood, and in the pericardial lympho-pus, more abundantly than any other organism; and it also occurred in the lung, but not so far as I ascertained in the kidney.

This bacillus was morphologically almost identical with the diphtheria bacillus, though on the whole rather shorter and more like the organism as it appears after it has passed through the cat. It showed the same tendency to become club-shaped at one end, though to a less pronounced extent. I could not find that it formed spores. In cultures in broth, on gelatine, and on Agar-agar, appearances were very similar. Gelatine cultures showed the same opaque prominent whitish growth as bacillus diphtheriæ, and almost the only distinction lay in the greater vigour of growth of the pyæmia organism.

Guinea-pigs were inoculated subcutaneously with this bacillus from pyæmia, but did not die till from 11 to 25 days after injection, thus showing a marked difference between this bacillus and that of diphtheria. Moreover, no local tumour developed at the site of injection. The spleen was small and pale, and the supra-renals large and dark, as after inoculation with diphtheria. The lungs were engorged, and showed hæmorrhages. There was no suppuration anywhere. Cultures from the blood and different organs of the experimental animals proved in all cases sterile, the bacilli having completely disappeared.

I have recorded these facts because of the close resemblance between this bacillus and the important diphtheria organism. There is manifestly, however, no sufficient evidence that the bacillus isolated had been the essential virus in the case of pyæmia whence it was derived.

Passing now to the observed life history within the bodies of experimental animals of the micro-organisms isolated by me from the above enumerated disease processes, I deal first with :—

## Staphylococcus Pyogenes.

Staphylococcus pyogenes (aureus and albus) are the organisms most commonly met with in acute abscesses, and it is not necessary to detail the cases in which I have found them. I have made, however, a number of observations of considerable interest in this respect.

During the course of some investigations on ulcerative endocarditis, Dr. Klein inoculated for me a series of 10 rabbits with staphylococcus pyogenes aureus, derived in some cases from the ulcerative endocarditis, in other cases from acute abscess of the breast. Each animal was inoculated in the vein of the ear, and received therein a small syringe-full of a broth culture of the organism, injected directly into the venous circulation. Other two had only half the amount injected. The results were as follows :—

(*a.*) *Resisting Power of the Rabbits* :—All of them died, but at very different periods. Two died in less than 20 hours ; one of these was full grown, one a half-grown animal. One died in 27 hours, and two more in 36 hours. One of the latter was only half grown. The remaining five lived longer, one surviving five days, three seven days, and one as many as 23 days. The last was one which had received only half a syringe-full of the staphylococcus culture.

The cause of death appeared in the earlier stages to be a direct poisoning by the cocci, or rather by some chemical product of their activity ; in cases of longer duration death appeared due to a septic embolic nephritis. In the animal which lived 23 days, no cause of death was found, though there was extreme muscular wasting.

(*b.*) *The fate of the Staphylococci within the Experimental Animals.* —There was considerable variation in the length of time which elapsed between inoculation of the staphylococcus and its disappearance from the blood of the experimental animal. In each case blood for examination was taken with a capillary pipette from the unopened heart, and several cultures made from it. As was to be expected, the colonies of staphylococcus were most numerous in those animals which had died most speedily ; in the case of those dying within 20 hours myriads of colonies sprung up. But in the case of death in 27 hours only a single colony appeared in one of three tubes, while in a case of death in 36 hours, all of four cultures remained absolutely sterile. On the other hand a number of colonies were obtained in a case where the animal had survived seven days, and two or three colonies in another case which lived the same time. Lastly, no organisms were present in the heart blood in three animals that lived 5, 7, and 23 days respectively.

It is hence clear that for the most part the cocci tend to disappear from the circulating blood more or less rapidly, sometimes very rapidly indeed ; and accordingly whether or not the theory of phagocytosis be true there can be no doubt that the circulating blood is not a favourable medium for the growth of staphylococcus aureus. It needs to be noted however that I met with one surprising exception, namely, that of a half-grown rabbit which had received a full dose of the culture. It died in 36 hours, and I found that the staphylococcus had grown and multiplied in its circulation to such an extent as almost to block the aorta down to the diaphragm ; forming within the vessel a number of whitish nodules like little polypi, feebly adherent to its wall, and with a fibrinous layer deposited here and there on them. As has been said,

in no other case did I find any evidence of multiplication of the organism in the circulating blood; the process was always one of destruction and not of increase.

Modern views on phagocytosis naturally led me to make careful examination of the leucocytes in the blood. Spherical organisms are not, however, favourable for recognition, when enclosed in other cells. I constantly found within the white corpuscles stained granules of the size and shape of the cocci, but it was impossible to identify them as such with certainty.

Also I examined the principal viscera, both microscopically and by cultivations. The latter method I found the more reliable. The spleen almost invariably contained cocci, though not in the case which lived 23 days. Once or twice I was able to detect in the spleen tissue colonies of this organism which appeared active and growing. The liver also when examined showed by culture a few colonies, but it was very difficult to demonstrate the organisms in the liver tissue by staining. As commonly happens, the livers of these rabbits were often infested with psorosperms, and in these cases it was easy to demonstrate large numbers of cocci within the capsules containing the psorosperms, though not in the psorosperms themselves; in other words, the cocci seemed able to flourish when just outside the pale of the active vital processes of the tissue. Occasionally small colonies of the cocci could be demonstrated in the lungs, and in one case I got a number of colonies from the fluid of a small pleural effusion.

The most constant phenomenon was capillary embolism, plugs of staphylococci blocking the vessels. As has been found by all investigators, the kidneys had suffered chiefly from this process; infarctions were present in every case, and the kidneys were sometimes immensely enlarged, and in a condition of acute nephritis. The heart muscle was also found infarcted in one case. In no case was any infarct found in the liver, spleen, or lungs. I am not aware that the capillaries of the kidney are of narrower calibre than those of the other viscera, nor has any sufficient explanation of the above phenomenon been offered. The result of the process is apparently beneficial in one respect; the organisms are excreted in the urine in vast numbers. In every case which I examined, urine drawn with a pipette from the bladder after death was found turbid with cocci, and yielded myriads of colonies of pure staphylococcus aureus on cultivation.

(*c.*) *Changes in the Tissues of the Experimental Animals.*—In no single instance was any definite abscess found in the tissues as a result of capillary embolism by cocci; though once there was some pus present in the pelvis of each kidney. This pus, which contained a vast number of cocci, was not in any special abscess cavity. I imagine that death occurred before the processes of inflammation had advanced sufficiently far, but in the case of the animal which lived 23 days there was no sign of any commencing abscess; every coccus had been disposed of.

The kidney changes could be followed from the earliest stages, and I found them substantially the same as described by Watson Cheyne and others. The primary process consisted in plugging of the vasa recta and medullary capillaries by pure masses of cocci, which often mapped out the branching capillaries in the most exquisite manner. The glomeruli and cortical vessels usually escaped; occasionally a plug was found in the cortex, and often about the junction of cortex and medulla. The next stage consisted in the growth of colonies from the mass forming the primary plug; this sometimes remained massive for a

time, merely distending and contorting the vessel, but soon the cocci invaded the adjacent uriniferous tubules, in which they were often present in large numbers near the primary infarct, scattered in small groups and evidently multiplying actively. Necrosis of the tissues then took place in these areas; they stained feebly with aniline dyes. The naked eye appearance of a kidney in this or a somewhat earlier stage was normal till it was cut open, when radiating whitish streaks were visible in the pyramids, few or numerous, and not as a rule reaching further than the junction of cortex and medulla. Hæmorrhages were sometimes present in the cortex, and microscopic examination showed the presence of a diffuse nephritis.

The next stage consisted in the increase in size of the above necrotic islets, and the development of a marked zone of leucocyte infiltration at their periphery, serving apparently as a barrier against the further encroachments of the cocci. Within this zone dotted groups of cocci could be found throughout the necrotic area, and often in the middle of it larger and more massive groups marking the site of the original embolus. The latter, however, could not be made out in the most advanced cases. This is the last stage which I was able to observe; I imagine that, had the animals lived, the breaking down of the necrotic patches would have resulted in abscess formation. In the rabbit which lived 23 days the kidneys were normal, and it is not likely that this particular animal would ever have developed the above changes, or some trace of them would have been apparent.

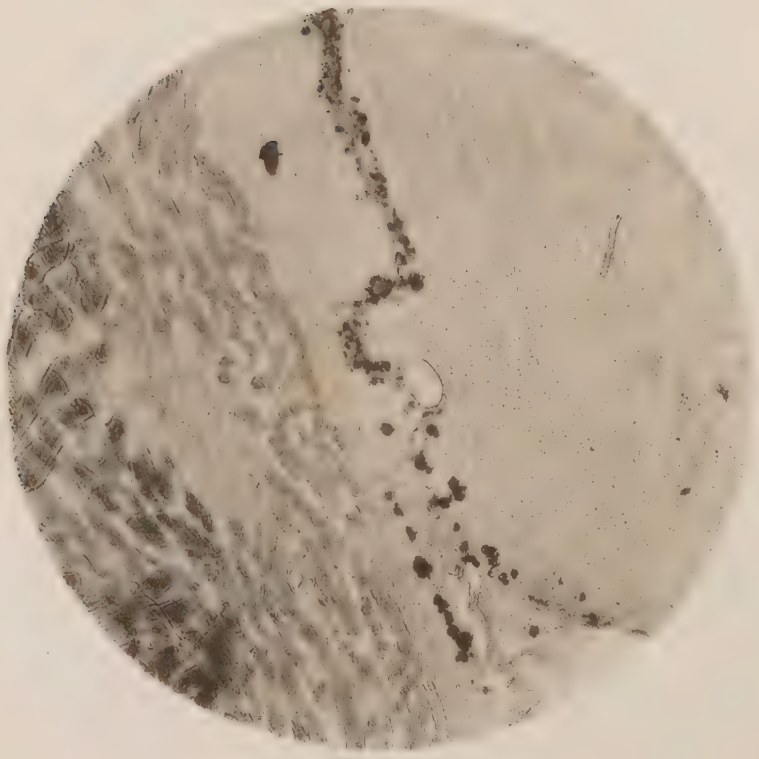
In the heart muscle precisely similar changes were found around the infarctions.

PLATE X.

FIG. 1.

FIG. 2.

FIG. 3.



## "CONDITIONS DETERMINING INSUSCEPTIBILITY."

### PLATE X.

FIG. 1.

Reproduced from a photograph of a section through the local thickening of tissue at the site of inoculation in a guinea-pig that died on the *sixth day* after subcutaneous injection of it with culture of *proteus vulgaris*.

Magnified 400 times.

[The dark masses here depicted represent intermuscular capillaries crowded with the proteus organism.]

FIG. 2.

Reproduced from a photograph of a section through the locally induced tumour of a guinea-pig that was killed on the *nineteenth day* after subcutaneous inoculation of it with *bacillus diphtheriæ*.

Magnified 60 times.

[The dark masses shown in the photograph are clumps of bacilli in the midst of unstained necrotic tissue wherein no leucocytes could be detected.]

FIG. 3.

Reproduced from a photograph of a section through the locally induced tumour of a guinea-pig that died on the *sixth day* after subcutaneous inoculation of it with *bacillus diphtheriæ*.

Magnified 60 times.

[As in fig. 2, the bacilli occur in clumps, and around them there is no infiltration of leucocytes.]

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[*The photographs for this volume were taken by Mr. E. C. Bousefield. The "reproductions" of the photographs are by the Autotype Company.*]

## "CONDITIONS DETERMINING INSUSCEPTIBILITY."

### PLATE XI.

FIG. 4.

Represents the clumps of diphtheria bacilli in fig. 3, viewed under a higher power.

Magnified 400 times.

FIG. 5.

Represents the clumps of diphtheria bacilli in fig. 2, viewed under a higher power.

Magnified 400 times.

PLATE XI.

FIG. 4.

FIG. 5.

# APPENDIX C.



## Index to the "Abstracts of Medical Inspections" contained in the volumes of the Medical Officer's Annual Reports for the 11 years 1880–1890.

The names of localities inspected are arranged alphabetically. The reports printed in *italics* have been reproduced in the Medical Officer's annual volumes; those marked * have been separately placed on sale; and those marked † have not been printed.

[See further Index on page 294.]

*The inspections made in connexion with the Cholera Survey of* 1885–86 *are not here included, but will be found tabulated in the Report of* 1885 *on Cholera, and in the Annual Volume of* 1886 *of the Medical Officer* [*C.* 4873 *and C.* 5171].

| No. | Locality Inspected. | Medical Inspector. | Year. |
|---|---|---|---|
| 1 | Abergele and Pensarn U.S.D. | Dr. Parsons | 1881 |
| 2 | Aldershot U.S.D.† | „ Turner | 1886 |
| 3 | Alnwick and Canongate U.S.D.* | Mr. Spear | 1884 |
| 4 | Alvastou and Boulton U.S.D.† | Dr. Parsons | 1890 |
| 5 | Amble U.S.D.† | Mr. Power | 1883 |
| 6 | Ampthill R.S.D.† | Dr. Thorne | 1882 |
| 7 | Andover R.S.D.† | „ Blaxall | 1882 |
| 8 | "Arethusa" Training Ship† | Mr. Power | 1880 |
| 9 | *Arlford (near Chester)* | Dr. Ballard | 1881 |
| 10 | *Arnesby (printed only in annual volume)* | Mr. Spear | 1887 |
| 11 | Ash† | Dr. Turner | 1886 |
| 12 | *Ashbourne U.S.D.** | „ Bruce Low | 1888 |
| 13 | Ashton-under-Lyne U.S.D. | „ Ballard | 1882 |
| 14 | Atherton U.S.D. | „ Parsons | 1886 |
| 15 | Aveley† | Mr. Spear | 1880 |
| 16 | *Aylesbury U.S.D.* | Dr. Gresswell | 1888 |
| 17 | *Aylesbury U.S.D.** | Mr. Spear | 1888 |
| 18 | *Bangor U. and R., and Bethesda U., S.D.'s* | Dr. Barry | 1882 |
| 19 | Bangor U.S.D.† | Do. | 1884 |

Note.—Throughout this Index, U.S.D. and R.S.D. denote respectively Urban and Rural Sanitary District.

| No. | Locality Inspected. | Medical Inspector. | Year. |
|---|---|---|---|
| 20 | Barkingside - - - - | Dr. Thorne - | 1880 |
| 21 | Barnstaple R.S.D.* - - - | „ Bruce Low - | 1890 |
| 22 | *Barrowby* - - - - - | „ Parsons - | 1890 |
| 23 | Barrow-on-Soar R.S.D.† - - - | „ Barry - - | 1883 |
| 24 | „ „ Registration District† - | Do. - - | 1883 |
| 25 | „ „ R.S.D.† - - - | „ Parsons - | 1886 |
| 26 | Bath R.S.D.† - - - - | „ Thorne - | 1880 |
| 27 | Beddington Royal Female Orphan Asylum* | „ Gresswell - | 1886 |
| 28 | Bedlingtonshire U.S.D.* - - - | „ Parsons - | 1889 |
| 29 | Bedwellty Registration District - - | Mr. Spear - - | 1882 |
| 30 | „ „ „ - - | Do. - - | 1884 |
| 31 | *Berkhamstead R.S.D.** - - - | Dr. Blaxall - | 1890 |
| 32 | Berwick-upon-Tweed U.S.D.* - - | „ Page - - | 1888 |
| 33 | *Beverley U.S.D.** - - - - | Do. - - | 1884 |
| 34 | Bishops Lydiard, &c. - - - | „ Blaxall - | 1882 |
| 35 | Bishop's Stortford R.S.D. - - - | Mr. Sweeting - | 1885 |
| 36 | Blaby R.S.D. - - - - | Dr. Blaxall - | 1880 |
| 37 | *Blackburn U. and R.S.D.'s* - - | „ Airy - - | 1881 |
| 38 | Blackburn R.S.D. - - - - | „ Parsons - | 1889 |
| 39 | Blackwater River† - - - - | „ Turner - | 1886 |
| 40 | Bodmin Registration District - - | „ Parsons - | 1881 |
| 41 | „ U.S.D.† - - - - | Do. - - | 1885 |
| 42 | „ R.S.D.† - - - - | Do. - - | 1885 |
| 43 | *Bourne Bridge and Stapleford Abbotts* - | „ Airy - - | 1881 |
| 44 | Box† - - - - - | „ Blaxall - | 1880 |
| 45 | *Bradford, &c., &c., &c.* (*Woolsorters' disease*). | Mr. Spear - - | 1880 |
| 46 | *Bridgend Registration District* - - | Do. - - | 1888 |
| 47 | Bridlington U.S.D. - - - - | Dr. Parsons - | 1881 |
| 48 | Brierley Hill U.S.D.† - - - | Do. - - | 1882 |
| 49 | Brinkworth* - - - - | „ Bruce Low - | 1890 |
| 50 | Brixworth R.S.D. - - - - | „ Parsons - | 1885 |
| 51 | Buckingham U.S.D.* - - - | Do. - - | 1888 |

Index to "Abstracts of Medical Inspections," 1880–1890.

| No. | Locality Inspected. | Medical Inspector. | Year. |
|---|---|---|---|
| 52 | Buckingham R.S.D. | Dr. Gresswell | 1889 |
| 53 | Burnham U.S.D. | „ Blaxall | 1883 |
| 54 | Burnley U.S.D. | „ Airy | 1884 |
| 55 | Buxted and Maresfield* | Do. | 1887 |
| 56 | Calne U.S.D. | „ Blaxall | 1884 |
| 57 | Calver† | „ Bruce Low | 1890 |
| 58 | Camberley and York Town | „ Parsons | 1889 |
| 59 | *Camelford R.S.D.* | „ Ballard | 1888 |
| 60 | Castleford Registration Sub-District | „ Parsons | 1880 |
| [61 | *Cerebro Spinal Meningitis**] *Eastern Counties.* | „ Bruce Low | 1890 |
| 62 | Cheshunt U.S.D.* | Mr. Sweeting | 1885 |
| 63 | Chester U.S.D.* | Dr. Ballard | 1889 |
| 64 | Chippenham R.S.D. (part of) | „ Blaxall | 1884 |
| 65 | Chorley (Lancs.) U.S.D. | „ Parsons | 1881 |
| 66 | Clapham | Do. | 1882 |
| 67 | Cleator Moor U.S.D.† | „ Page | 1888 |
| 68 | Clitheroe R.S.D. | „ Airy | 1880 |
| 69 | Coggeshall* | Do. | 1882 |
| 70 | Colne and Marsden U.S.D.† | Do. | 1884 |
| 71 | Congleton U.S.D.† | „ Page | 1888 |
| 72 | "Cornwall" School Ship† | Mr. Power | 1881 |
| 73 | Corwen R.S.D. | Dr. Parsons | 1881 |
| 74 | *Coslany Registration Sub-District** | „ Airy | 1888 |
| 75 | Cowpen U.S.D. | „ Parsons | 1889 |
| 76 | *Cradley** | „ Gresswell | 1889 |
| 77 | Cranbrook R.S.D.* | „ Airy | 1887 |
| 78 | Cricklade and Wootton Bassett R.S.D.† | „ Thorne | 1880 |
| 79 | Croydon R.S.D.† | „ Page | 1883 |
| 80 | Dalham† | „ Turner | 1886 |
| 81 | Dartford U. and R.S.D.'s | Mr. Spear | 1882 |
| 82 | „ Registration Sub-District | Do. | 1884 |
| 83 | Darton Registration Sub-District† | Dr. Bruce Low | 1889 |

| No. | Locality Inspected. | Medical Inspector. | Year. |
|---|---|---|---|
| 84 | Denbigh - - - - - | Dr. Parsons - | 1881 |
| 85 | *Devonport** - - - - - | Do. - - | 1883 |
| 86 | Dingestow Registration Sub-District* - | Mr. Spear - - | 1888 |
| 87 | Dolgelley U.S.D. - - - - | Dr. Parsons - | 1888 |
| 88 | *Donington and Moulton* - - - | „ Page - - | 1883 |
| 89 | Donington and Moulton† - - - | Do. - - | 1884 |
| 90 | Durham Registration District - - | Mr. Spear - - | 1881 |
| 91 | *Ealing U.S.D.** - - - - | „ Power - | 1887 |
| 92 | Easingwold R.S.D.* - - - | Dr. Barry - - | 1890 |
| 93 | East Haddon - - - - | „ Bruce Low - | 1889 |
| 94 | *Eastry R.S.D.* - - - - | Mr. Spear - - | 1887 |
| 95 | Edmonton U.S.D. - - - - | Dr. Parsons - | 1880 |
| 96 | Ely R.S.D.† - - - - | Do. - - | 1885 |
| 97 | Enfield U.S.D. - - - - | Do. - - | 1880 |
| 98 | *Enfield U.S.D.** - - - - | „ Bruce Low - | 1888 |
| 99 | Erpingham R.S.D. - - - - | „ Gresswell - | 1885 |
| 100 | Eversholt* - - - - - | „ Parsons - | 1884 |
| 101 | Exmouth U.S.D. - - - - | Do. - - | 1888 |
| 102 | Faldingworth and Barlings - - - | „ Gresswell - | 1885 |
| 103 | *Fareham Registration District** - - | Mr. Spear - - | 1888 |
| 104 | *Faringdon R.S.D.* - - - - | Do. - - | 1889 |
| 105 | Farnborough† - - - - | Dr. Turner - | 1886 |
| 106 | Farnham Registration District - - | Mr. Sweeting - | 1885 |
| 107 | Farnham U.S.D.† - - - - | Dr. Turner - | 1886 |
| 108 | Faversham U.S.D. - - - - | Mr. Power - | 1880 |
| 109 | „ R.S.D. - - - - | Do. - - | 1880 |
| 110 | Felstead - - - - - | Dr. Airy - - | 1880 |
| 111 | Flint U.S.D.† - - - - | Mr. Spear - - | 1888 |
| 112 | Folkestone - - - - - | Dr. Parsons - | 1882 |
| 113 | Forest Row and East Hoathley - - | „ Airy - - | 1880 |
| 114 | Frimley† - - - - - | „ Turner - | 1886 |
| 115 | Galgate - - - - - | „ Barry - | 1882 |

| No. | Locality Inspected. | Medical Inspector. | Year. |
|---|---|---|---|
| 116 | Gateshead U.S.D.* - - - - | Dr. Barry - - | 1883 |
| 117 | Glanaber - - - - - | „ Airy - - | 1880 |
| 118 | Glanford Brigg R.S.D.* - - - | „ Gresswell - | 1885 |
| 119 | Godmanchester U.S.D. - - - | „ Parsons - | 1884 |
| 120 | Gravesend U.S.D.* - - - - | Mr. S. F. Murphy - | 1885 |
| 121 | Grays Registration Sub-District - - | Dr. Airy - - | 1889 |
| 122 | Great Dunmow* - - - - - | Do. - - | 1883 |
| 123 | Great Grimsby U.S.D. - - - | „ Parsons - | 1881 |
| 124 | Great Ormond Street Hospital - - | Mr. Power - - | 1880 |
| 125 | Guildford R.S.D.† - - - - | Do. - - | 1882 |
| 126 | Gunnislake - - - - - | Dr. Blaxall - | 1881 |
| 127 | *Halifax* - - - - - | „ Ballard - | 1881 |
| 128 | *Halstead Registration District** - - | „ Bruce Low - | 1889 |
| 129 | Hambledon, &c.* - - - - | „ Parsons - | 1884 |
| 130 | „ R.S.D.* - - - | „ Airy - - | 1887 |
| 131 | Hanley U.S.D.* - - - - | Mr. Spear - - | 1889 |
| 132 | Hastings (St. Mary in the Castle Sub-District).† | „ Spear - - | 1890 |
| 133 | Hatfield R.S.D. - - - - | Dr. Bruce Low - | 1889 |
| 134 | Haverfordwest - - - - | „ Parsons - | 1880 |
| 135 | Hayfield R.S.D. - - - - | Do. - | 1886 |
| 136 | Heage U.S.D. - - - - | Do. - | 1883 |
| 137 | Heath Town U.S.D. - - - | Mr. Spear - - | 1884 |
| 138 | Hebden Bridge Registration Sub-District - | Dr. Gresswell - | 1885 |
| 139 | Helston, Falmouth, and Redruth U. and R. S.D.'s† | „ Ballard - | 1882 |
| 140 | *Helston U.S.D.** - - - - | „ Parsons - | 1887 |
| 141 | „ *R.S.D.** - - - - | Do. - | 1887 |
| 142 | Hemel Hempstead R.S.D. - - - | Mr. Sweeting - | 1885 |
| 143 | *Hendon U.S.D.** - - - - | „ Power - - | 1883 |
| 144 | Henley and Barham - - - | Dr. Airy - - | 1880 |
| 145 | Hinckley U.S.D.† - - - - | Do. - - | 1881 |
| 146 | Hindley U.S.D.† - - - - | Mr. Spear - - | 1882 |
| 147 | „ „ - - - - | Dr. Parsons - | 1886 |

| No. | Locality Inspected. | Medical Inspector. | Year. |
|---|---|---|---|
| 148 | *Hitchin U.S.D.** | Mr. Power | 1883 |
| 149 | Hitchin R.S.D. | „ Sweeting | 1885 |
| 150 | Holbeach R.S.D. | Dr. Parsons | 1882 |
| 151 | Hollingbourn R.S.D. | Do. | 1886 |
| 152 | Holme Cultram U.S.D. | Do. | 1888 |
| 153 | Holyhead R.S.D.† | Mr. Harvey | 1886 |
| 154 | Holywell R.S.D. | Dr. Parsons | 1881 |
| 155 | „ U.S.D. | Do. | 1881 |
| 156 | Hoo R.S.D. | „ Airy | 1881 |
| 157 | „ „ | Mr. Spear | 1889 |
| 158 | Horwich Registration Sub-District | Do. | 1889 |
| 159 | *Houghton-le-Spring R.S.D.** | Dr. Page | 1889 |
| 160 | Howden R.S.D. | Mr. Spear | 1881 |
| 161 | Hull U.S.D. | Dr. Airy | 1882 |
| 162 | Huntingdon Registration District | „ Parsons | 1880 |
| 163 | „ U.S.D. | Do. | 1884 |
| 164 | Ilkeston U.S.D. | „ Blaxall | 1881 |
| 165 | *Ivybridge U.S.D. (Reprinted in Volume for* 1886.)* (*Small-pox among Rag-Sorters.*) | „ Parsons | 1887 |
| 166 | Kempston* | Mr. Sweeting | 1885 |
| 167 | Keynsham R.S.D. | „ Blaxall | 1888 |
| 168 | Kidderminster U.S.D.* | „ Parsons | 1884 |
| 169 | „ „ | Do. | 1885 |
| 170 | *Kilkhampton* | Do. | 1888 |
| 171 | Kingsbridge R.S.D.† | „ Ballard | 1882 |
| 172 | Kingsclere and East Woodhay (R.S.D.) | „ Blaxall | 1884 |
| 173 | King's Lynn | „ Airy | 1882 |
| 174 | Launceston R.S.D.† | „ Parsons | 1884 |
| 175 | Leek R.S.D. | Do. | 1889 |
| 176 | Llandewyrewm | „ Airy | 1880 |
| 177 | Llandissilio Registration Sub-District | Mr. Spear | 1888 |
| 178 | Llanelly U.S.D. | Dr. Parsons | 1880 |

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| No. | Locality Inspected. | Medical Inspector. | Year. |
|---|---|---|---|
| 179 | Llanfrechfa, Upper, U.S.D.† - - | Mr. Spear - - | 1883 |
| 180 | Llanfyllin R.S.D. - - - - | Dr. Parsons - | 1881 |
| 181 | Llangollen U.S.D. - - - - | Do. - | 1881 |
| 182 | Llanllyfni and Llanwnda - - - | „ Airy - - | 1880 |
| 183 | Llanwddyn - - - - - | „ Parsons - | 1888 |
| 184 | Long Eaton U.S.D.† - - - | „ Turner - | 1886 |
| 185 | Longton U.S.D.* - - - - | Mr. Spear - - | 1889 |
| 186 | Loughton† - . - - - | Do. - | 1880 |
| 187 | *Lower Brixham U.S.D.* - - - | Dr. Blaxall - | 1888 |
| 188 | Lower Sheringham† - - - | „ Airy - - | 1885 |
| 189 | Lurgashall - - - - - | Do. - - | 1880 |
| 190 | Maesteg U.S.D.* - - - - | Mr. Spear - - | 1889 |
| 191 | Manorbier - - - - - | Dr. Airy - - | 1880 |
| 192 | Mansfield Registration District - - | „ Gresswell - | 1885 |
| 193 | Margate U.S.D.* - - - - | „ Page - - | 1887 |
| 194 | Marham† - - - - - | „ Parsons - | 1887 |
| 195 | Market Weighton† - - - - | Mr. A. Royle - | 1885 |
| 196 | Maryport U.S.D. - - - - | „ Spear - - | 1882 |
| 197 | Mathry and Llanrian - - - | Dr. Parsons - | 1880 |
| 198 | *Melton Mowbray U.S.D.* - - - | „ Blaxall - | 1880 |
| 199 | Melton Mowbray R.S.D.† - - - | Do. - | 1881 |
| 200 | *Middlesbrough U.S.D.** - - - | „ Ballard - | 1888 |
| 201 | *Midsomer Norton U.S.D.** - - - | „ Blaxall - | 1888 |
| 202 | Millbrook - - - - - | „ Ballard - | 1880 |
| 203 | „ † - - - - | Do. - | 1882 |
| 204 | Motcombe - - - - - | „ Simpson - | 1885 |
| 205 | Moulton† - - - - | „ Turner - | 1886 |
| 206 | *Mountain Ash U.S.D.** - - - | Mr. Spear - - | 1887 |
| 207 | Mytholmroyd (in four Sanitary Districts)* - | Dr. Page - - | 1888 |
| 208 | "*Nazareth House*," *Hammersmith* - | Mr. Spear - - | 1883 |
| 209 | *Neath R.S.D. (part of)* - - - | Do. - - | 1890 |
| 210 | Newark U.S.D. - - - - - | Dr. Parsons - | 1885 |

| No. | Locality Inspected. | Medical Inspector. | Year. |
|---|---|---|---|
| 211 | *New Brighton** - - - - - | Mr. Spear - - | 1888 |
| 212 | *New Clee** - - - - - - | Dr. Page - - | 1888 |
| 213 | Newlyn, East - - - - - | „ Ballard - | 1880 |
| 214 | Newport Pagnell R.S.D. - - - | „ Parsons - | 1884 |
| 215 | New Shoreham U.S.D.† - - - | „ Thorne - | 1882 |
| 216 | Newton Heath U.S.D.† - - - | Do. - - | 1880 |
| 217 | Newtown and Llanllwchaiarn U.S.D.† - | „ Blaxall - | 1880 |
| 218 | Nocton Rise Farmhouse† - - - | „ Gresswell - | 1885 |
| 219 | Northallerton U.S.D.† - - - | „ Page - - | 1887 |
| 220 | North and South Tawton - - - | „ Blaxall - | 1881 |
| 221 | *North London* (3 *Districts*)* - - | Mr. Power - - | 1885 |
| 222 | *Northop Hall* - - - - - | „ Spear - - | 1890 |
| 223 | *Norwood* (*Uxbridge R.S.D.*) - - | „ Power - | 1882 |
| 224 | Nottingham - - - - - - | Dr. Ballard - | 1881 |
| 225 | *Oaksey* - - - - - - | „ Downes - | 1883 |
| 226 | *Okehampton R.S.D.* - - - | „ Blaxall - | 1887 |
| 227 | Ormskirk R.S.D. - - - - | „ Parsons - | 1883 |
| 228 | Orsett R.S.D. - - - - | Mr. Spear - - | 1883 |
| 229 | Oswaldtwistle U.S.D. - - - | Do. - - | 1887 |
| 230 | Pemberton U.S.D. - - - - | Dr. Airy - - | 1880 |
| 231 | „ „ - - - - | Mr. Spear - - | 1890 |
| 232 | *Pembroke R.S.D.* - - - - | Do. - - | 1890 |
| 233 | Penistone Registration Sub-District* - | Mr. Spear - - | 1889 |
| 234 | Petersfield R.S.D.† - - - - | Dr. Turner - | 1886 |
| 235 | *Pirbright* - - - - - - | Mr. Power - - | 1882 |
| 236 | Plymouth - - - - - - | Dr. Blaxall - | 1882 |
| 237 | Plympton St. Mary R.S.D.† - - | „ Ballard - | 1882 |
| 238 | Pontardawe Registration District (R.S.D.) - | „ Parsons - | 1880 |
| 239 | Pontypridd Registration Sub-District* - | Mr. Spear - - | 1889 |
| 240 | Portland U.S.D.† - - - - - | Dr. Blaxall - | 1886 |
| 241 | Potton* - - - - - - | „ Parsons - | 1882 |
| 242 | Putney† - - - - - - | „ Blaxall - | 1883 |

| No. | Locality Inspected. | Medical Inspector. | Year. |
|---|---|---|---|
| 243 | Pwllheli U.S.D.* - - - - | Dr. Parsons - | 1887 |
| 244 | „ R.S.D. - - - - | Do. - | 1887 |
| 245 | Queen Camel* - - - - | Do. - | 1888 |
| 246 | Raunds - - - - - | „ Airy - - | 1880 |
| 247 | *Rawdon U.S.D.* - - - - | „ Barry - - | 1890 |
| 248 | *Retford, East, R.S.D. (printed only in annual volume).* | Mr. Spear - - | 1887 |
| 249 | Rhayader R.S.D.† - - - - | Do. - - | 1889 |
| 250 | Rhymney U.S.D.† - - - - | Mr. Power - - | 1880 |
| 251 | Rochdale - - - - - | Dr. Thorne - | 1882 |
| 252 | *Rochester U.S.D.* - - - - | Mr. Spear - - | 1889 |
| 253 | Romford R.S.D. - - - - | Dr. Parsons - | 1884 |
| 254 | Rothwell U.S.D.† - - - - | Do. - - | 1882 |
| 255 | Runcorn U.S.D.* - - - - | Mr. Spear - - | 1890 |
| 256 | Ruthin R.S.D. - - - - | Dr. Parsons - | 1881 |
| 257 | „ U.S.D. - - - - | Do. - | 1881 |
| 258 | Rye R.S.D.* - - - - | Mr. Spear - - | 1889 |
| 259 | *St. Albans U.S.D.** - - - | „ S. F. Murphy - | 1884 |
| 260 | St. Ann's Chapel - - - - | Dr. Blaxall - | 1881 |
| 261 | St. Asaph R.S.D. - - - - | „ Parsons - | 1881 |
| 262 | *St. Austell R.S.D.* - - - - | Do. - - | 1888 |
| 263 | St. George, Hanover Square† - - | „ Barry - - | 1889 |
| 264 | St. Helens (Lancs.) - - - | Mr. Spear - | 1882 |
| 265 | St. Ives (Hunts.) R.S.D.† - - - | Dr. Airy - - | 1881 |
| 266 | *St. Joseph's Industrial School, Manchester** | „ Page - - | 1888 |
| 267 | *St. Mary Cray, &c. (Small-pox among Rag Sorters).* | „ Parsons - | 1881 |
| 268 | *St. Pancras. (Printed only in annual volume.)* | Mr. Power - | 1882 |
| 269 | Sale U.S.D. - - - - | Dr. Parsons - | 1882 |
| 270 | Samford R.S.D. - - - - | „ Airy - - | 1889 |
| 271 | Sandal Registration Sub-District - - | Mr. Sweeting - | 1885 |
| 272 | *Scotter and Scotton** - - - | Dr. Parsons - | 1890 |
| 273 | Sculcoates R.S.D.* - - - | „ Barry - - | 1890 |
| 274 | Seend† - - - - - | Mr. Sweeting - | 1885 |

| No. | Locality Inspected. | Medical Inspector. | Year. |
|---|---|---|---|
| 275 | Shadwell - - - - - - | Mr. Spear - - | 1880 |
| 276 | Shaftesbury U.S.D. - - - | Dr. Simpson - | 1885 |
| 277 | Sheerness U.S.D.† - - - | Mr. Spear - - | 1884 |
| 278 | *Sheffield U.S.D.* (*Separate Volume.*) (*Small-pox Epidemic*, 1887–88.) | Dr. Barry - - | 1887 |
| 279 | Shepton Mallet R.S.D.† - - - | „ Gresswell - | 1885 |
| 280 | *Sherborne U.S.D.* - - - | „ Blaxall - | 1882 |
| 281 | Skelmanthorpe U.S.D.† - - - | „ Bruce Low - | 1889 |
| 282 | Smalley† - - - - - - | „ Page - - | 1887 |
| 283 | Southborough U.S.D. - - - | Mr. Spear - - | 1882 |
| 284 | Southend U.S.D. - - - - | Dr. Thorne - | 1880 |
| 285 | Sowerby Bridge U.S.D. - - - | „ Parsons - | 1889 |
| 286 | Spennymoor U.S.D. - - - | Do. - - | 1884 |
| 287 | „ „ * - - - | „ Page - - | 1888 |
| 288 | Spilsby R.S.D. - - - - | Mr. Spear - - | 1884 |
| 289 | *Staines R.S.D.** - - - - | Dr. Blaxall - | 1890 |
| 290 | *Stalybridge U.S.D.* - - - | Mr. Spear - - | 1890 |
| 291 | Standish with Langtree U.S.D.† - - | Dr. Page - - | 1888 |
| 292 | Stourbridge R.S.D. (Staffs Division)* - | „ Parsons - | 1888 |
| 293 | „ „ (Worcester Division)† | Do. - - | 1888 |
| 294 | Sutton-in-Ashfield U.S.D. - - - | Do. - - | 1882 |
| 295 | „ „ „ - - - | Do. - - | 1883 |
| 296 | Swanage U.S.D.* - - - - | Mr. Harvey - | 1886 |
| 297 | Taunton - - - - - | Dr. Blaxall - | 1882 |
| 298 | Tavistock R.S.D.† - - - - | Do. - - | 1881 |
| 299 | *Tees Valley* - - - - | „ Barry - - | 1890 |
| 300 | Tempsford† - - - - - | „ Parsons - | 1882 |
| 301 | Tendring R.S.D.† - - - - | Mr. Spear - - | 1890 |
| 302 | Thirsk R.S.D.† - - - - | Dr. Parsons - | 1889 |
| 303 | Thorne Registration District - - | Do. - - | 1883 |
| 304 | *Tichmarsh** - - - - - | Mr. Power - - | 1883 |
| 305 | Torpoint† - - - - - | Dr. Ballard - | 1882 |
| 306 | Totnes U. and R.S.D.'s - - - | „ Parsons - | 1880 |

| No. | Locality Inspected. | Medical Inspector. | Year. |
|---|---|---|---|
| 307 | Tottenham U.S.D. | Mr. Sweeting | 1885 |
| 308 | Tredegar U.S.D. | „ Spear | 1889 |
| 309 | Trimdon Colliery and Trimdon Grange† | Dr. Page | 1884 |
| 310 | Truro R.S.D.† | „ Parsons | 1880 |
| 311 | Tynemouth Registration District* | „ Barry | 1883 |
| 312 | Uckfield U.S.D. | Mr. Power | 1881 |
| 313 | Ulverston U.S.D. | „ Spear | 1882 |
| 314 | *Upton** | Dr. Parsons | 1889 |
| 315 | *Ure River* | Mr. Sweeting | 1885 |
| 316 | Uxbridge U.S.D.† | Dr. Bruce Low | 1889 |
| 317 | Vron† | Mr. Spear | 1887 |
| 318 | Walsall R.S.D.† | Dr. Thorne | 1881 |
| 319 | Walsingham R.S.D. | „ Gresswell | 1885 |
| 320 | Walthamstow U.S.D. | „ Airy | 1888 |
| 321 | Walton-on-the-Naze U.S.D. | „ Parsons | 1881 |
| 322 | Ware R.S.D. | Do. | 1884 |
| 323 | Watford U.S.D. | Mr. Sweeting | 1885 |
| 324 | *Welbeck* | Dr. Ballard | 1880 |
| 325 | Wellingborough R.S.D.† | Mr. Spear | 1889 |
| 326 | Wellington (Som.) U.S.D. | Dr. Simpson | 1885 |
| 327 | „ „ R.S.D. | Do. | 1885 |
| 328 | *Wells (Norfolk) U.S.D.* | Mr. Spear | 1890 |
| 329 | West Cowes U.S.D. | Do. | 1886 |
| 330 | Weston-super-Mare U.S.D. | „ Blaxall | 1882 |
| 331 | Whitford Registration Sub-District | „ Parsons | 1888 |
| 332 | Whitstable | Mr. Power | 1883 |
| 333 | Whixley Registration Sub-District* | „ Sweeting | 1885 |
| 334 | Wight, Isle of | Dr. Ballard | 1880 |
| 335 | Williton R.S.D.† | Do. | 1881 |
| 336 | *Wimbledon U.S.D.* | Mr. Power | 1886 |
| 337 | Wincanton R.S.D.† | Dr. Airy | 1884 |
| 338 | „ „ | „ Parsons | 1886 |

| No. | Locality Inspected. | Medical Inspector. | Year. |
|---|---|---|---|
| 339 | Winchester U.S.D. - - - | Dr. Parsons - | 1887 |
| 340 | Windsor U.S.D. - - - - | „ Airy and Mr. A. Taylor. | 1886 |
| 341 | „ „ - - - - | Do. - | 1889 |
| 342 | Wisbech R.S.D. - - - | Dr. Page - - | 1883 |
| 343 | Wombwell U.S.D. - - - - | „ Parsons - | 1886 |
| 344 | Woolfardisworthy - - - | „ Airy - - | 1880 |
| 345 | Woolwich U.S.D. - - - - | Mr. Spear - - | 1884 |
| 346 | Worcester U.S.D.† - - - - | Dr. Parsons - | 1889 |
| 347 | Workington U.S.D.† - - - | „ Page - - | 1888 |
| 348 | Yateley† - - - - - | „ Turner - | 1886 |
| 349 | *York U.S.D.** - - - - | „ Airy - - | 1884 |
| 350 | *York Town and Camberley** - - | Mr. Power - | 1886 |

*The following localities have been inspected, wholly or in part, in the inquiries, in the foregoing Table, the number of which is placed against their names:—*


Abertillery U.S.D. (1882) - *See* 29
„ „ (1884) - „ 30
Aldershot U.S.D. (1885) - „ 106
„ „ (1886) - „ 39
Altofts U.S.D. - - - - „ 271
Auckland R.S.D. - - - „ 287
Aysgarth R.S.D. - - - „ 315
Bakewell R.S.D. - - - „ 57
Barlings - - - - „ 102
Barnsley R.S.D. - - - „ 83
Bedale R.S.D. - - - - „ 315
Beddgelert - - - - „ 117
Bedford R.S.D. - - - „ 165
Bedwellty R.S.D. (1882) - „ 29
„ „ (1884) - „ 30
Belgrave U.S.D. - - - „ 24
Belper R.S.D. - - - - „ 282
Bideford R.S.D. - - - „ 344
Biggleswade R.S.D. (1882) - „ 241
„ „ „ - „ 300
Blean R.S.D. - - - - „ 332
Bodmin U. and R.S.D.'s - „ 40
Bolton R.S.D. - - - - „ 158
Bosmere and Claydon R.S.D. - „ 144
Braintree R.S.D. - - - „ 69
Brandon and Byshottles U.S.D. *See* 90
Bridgend U.S.D. - - - „ 46
„ R.S.D. - - - „ 46
Brixworth R.S.D. - - - „ 93
Bromley R.S.D. - - - „ 267
Builth R.S.D. - - - - „ 176
Camberley (1886) - - - „ 350
Camberwell - - - - „ 268
Camborne U.S.D. - - - „ 139
Carnarvon R.S.D. - - - „ 182
Castleford U.S.D. - - - „ 60
Chelsea Parish - - - „ 263
Chippenham R.S.D. - - - „ 44
Chipping - - - - „ 68
Clee with Weelsby U.S.D. - „ 212
Cowbridge U.S.D. - - - „ 46
Cowpen U.S.D. (1883) - „ 311
Cramlington U.S.D. - - - „ 311
Croydon R.S.D. - - - „ 27
„ „ - - „ 336
Crowle U.S.D. - - - „ 303
Dartford U.S.D. - - - „ 82
„ R.S.D. - - - „ 82
Darton U.S.D. - - - - „ 83
Dorking R.S.D. - - - „ 125

Downham R.S.D. - - *See* 194
Droxford R.S.D. - - „ 129
Dunmow R.S.D. (1880) - „ 110
„ „ (1883) - „ 122
Durham U. and R.S.D.'s (1881) „ 90
„ R.S.D. (1888) - „ 287
East Cowes U.S.D. - - „ 334
East Grinstead R.S.D. - - „ 113
East Hampstead R.S.D. - „ 39
Ebbw Vale U.S.D. (1882) - „ 29
„ „ „ (1884) - „ 30
Edmonton U.S.D. - - „ 98
Epping R.S.D. - - „ 186
Erpingham R.S.D. (1885) - „ 188
Eston U.S.D. - - - „ 200
Falmouth R.S.D. - - „ 139
„ U.S.D., town and parish - - - „ 139
Fareham U.S.D. - - „ 103
„ R.S.D. - - „ 103
Farnham U.S.D. (1885) - „ 106
„ R.S.D. (1882) - „ 268
„ „ (1885) - „ 106
„ „ (1886) - „ 11
„ „ (1886) - „ 39
„ „ (1886) - „ 114
„ „ (1886) - „ 350
„ „ (1889) - „ 58
Festiniog R.S.D. - - „ 117
Fulham Board of Works District (one institution) - „ 208
Gainsborough R.S.D. - - „ 272
Gedney Drove End - - „ 150
Glanford Brigg R.S.D. - - „ 272
Godmanchester U.S.D. - „ 162
Grantham R.S.D. - - „ 22
Grays Thurrock U.S.D. - „ 121
Great Grimsby U.S.D. - „ 212
Great Ouseburn R.S.D. - „ 315
„ „ „ - „ 333
Gunthwaite and Ingbirchworth U.S.D. - - - „ 233
Halifax (1880) - - „ 45
Halstead R.S.D. - - „ 128
„ U.S.D. - - „ 128
Hambledon R.S.D. (1882) - „ 125
Hartley Wintney R.S.D. - „ 39
„ „ „ - „ 105
„ „ „ - „ 348
Haslemere - - - „ 180
Hastings R.S.D. - - „ 132
„ U.S.D. - - „ 132
Haverfordwest R.S.D. - - *See* 197
Hayle U.S.D. - - - „ 139
Hebden Bridge U.S.D. (1885) - „ 138
„ „ „ (1888) - „ 207
Hendon (1885) - - „ 221
Hern Hill (Faversham R.S.D.) „ 109
Holywell R.S.D. (1888) - „ 331
„ „ (1890) - „ 222
Horwich U.S.D. - - „ 158
Howdon U.S.D. - - „ 311
Hoylandswaine U.S.D. - „ 233
Hucknall-under-Huthwaite U.S.D. - - - „ 192
Hull Port - - - „ 161
Huntingdon U. and R.S.D.'s (1880) - - - „ 162
Keighley U.S.D. - - „ 45
Kensington Parish - - „ 263
Lancaster R.S.D. - - „ 115
Leyburn R.S.D. - - „ 315
Lincoln R.S.D. - - „ 102
„ „ (one house) - „ 218
Llanfyllin R.S.D. - - „ 183
London, Port of - - „ 1, 72
Lutterworth R.S.D. - - „ 10
Macclesfield U.S.D. - - „ 314
„ R.S.D. - - „ 314
Maesteg U.S.D. - - „ 46
Malmesbury R.S.D. (1883) - „ 225
„ „ (1890) - „ 49
Manchester U.S.D. (*one institution*) - - - - „ 266
Mansfield U.S.D. - - „ 324
„ R.S.D. - - „ 192
Maresfield (Uckfield R.S.D.) - „ 55
Masham U.S.D. - - „ 315
Melksham R.S.D. - - „ 274
Merton - - - „ 336
Messingham - - - „ 272
Methley U.S.D. - - „ 60
Midgley U.S.D. - - „ 207
Midhurst R.S.D. - - „ 189
Monmouth R.S.D. - - „ 86
Mountain Ash U.S.D. (1889) - „ 239
Narberth R.S.D. - - „ 177
Newmarket R.S.D. - - „ 80
„ „ - - „ 205
Newport (I.W.) - - „ 334
Normanby U.S.D. - - „ 200
Normanton U.S.D. - - „ 271
Norwich U.S.D. - - „ 74
Oakley, Brome, Scole, &c. - „ 61

Ogmore and Garw U.S.D. - *See* 46
Okehampton R.S.D. - - „ 220
Ongar R.S.D. - - - „ 43
Ormesby U.S.D. - - „ 200
Orrell - - - - „ 230
Orsett R.S.D. (1888) - - „ 15
„ „ (1889) - - „ 121
Pembroke R.S.D. - - „ 191
Penistone U.S.D. - - „ 233
„ R.S.D. - - „ 233
Penryn U.S.D. - - - „ 139
Phillack U.S.D. - - „ 139
Pocklington R.S.D. - - „ 195
Pontypridd U.S.D. - - „ 239
„ R.S.D. - - „ 239
Quorndon U.S.D. - - „ 24
Redruth R.S.D. - - „ 139
„ U.S.D. - - „ 139
Ripon U.S.D. - - - „ 315
„ R.S.D. - - - „ 315
Romford R.S.D. - - „ 20
Ryde (I.W.) - - - „ 334
St. Albans R.S.D. - - „ 259
St. Columb Major R.S.D. - „ 213
St. Faiths R.S.D. - - „ 74
St. George, Hanover Square (1882) - - - „ 268
St. Germans R.S.D. (1880) - „ 202
„ „ (1882) - „ 203
„ „ (1882) - „ 305
St. Giles, Bloomsbury - - „ 268
St. Helens (I.W.) - - „ 334
St. Martin-in-the-Fields - „ 268
Sandal Magna U.S.D. - - „ 271
Sandown U.S.D. - - „ 334
Sculcoates R.S.D. (1882) - „ 161
Sedgefield R.S.D. - - „ 309
Seghill U.S.D. - - - „ 311
Shaftesbury R.S.D. - - „ 204
Shanklin U.S.D. - - „ 334
Silloth (Holme Cultram) - „ 152
South Blyth and Newsham U.S.D. „ 311
Sowerby U.S.D. - - „ 207
Spalding R.S.D. (1883) - „ 88
Spalding, R.S.D. (1884) - *See* 89
Stanstead Abbots - - „ 322
Stocksbridge U.S.D. - - „ 233
Stourbridge R.S.D. - - „ 76
Stratton R.S.D. - - „ 170
Sutton in Ashfield U.S.D. - „ 192
Taunton R.S.D. - - „ 34
Tavistock R.S.D. - - „ 126
„ „ - - „ 260
Thrapston R.S.D. - - „ 246
„ „ - - „ 304
Thorne R.S.D. - - - „ 303
Thurlstone R.S.D. - - „ 233
Thurmaston U.S.D. - - „ 24
Todmorden R.S.D. (1885) - „ 138
„ „ (1888) - „ 207
Totnes R.S.D. - - - „ 187
Tynemouth U. and R.S.D.'s - „ 311
Uckfield R.S.D. - - „ 55
Uxbridge R.S.D. - - „ 223
Ventnor U.S.D. - - „ 334
Wakefield R.S.D. - - „ 271
Walker U.S.D. - - - „ 311
Wallasey U.S.D. - - „ 211
Wallsend U.S.D. - - „ 311
Wandsworth Board of Works District (1882) - - „ 66
Wandsworth Board of Works District (1883) - - „ 242
West Cowes U.S.D. - - „ 334
Westhoughton U.S.D. - - „ 158
Wetherby R.S.D. - - „ 275
Whaplode Drove - - „ 150
Whitley and Monkseaton U.S.D. „ 311
Whitwood U.S.D. - - „ 60
Wight, Isle of, R.S.D. - - „ 334
Willington Quay U.S.D. - „ 311
Wincanton R.S.D. (1888) - „ 245
Woburn R.S.D. - - „ 100
Worksop U.S.D. - - „ 324
Wrexham R.S.D. - - „ 317
York U.S.D. - - - „ 266
York Town - - - „ 58
Ystradyfodwg U.S.D. - - „ 239